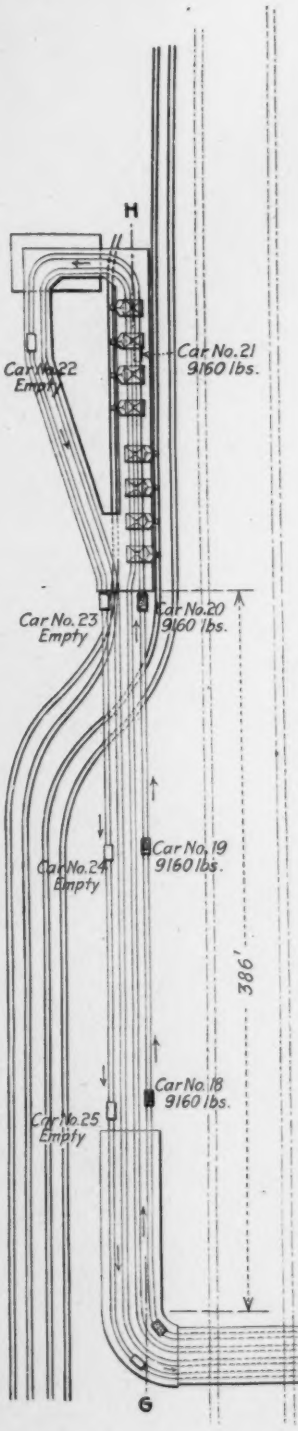

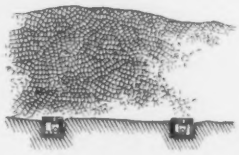

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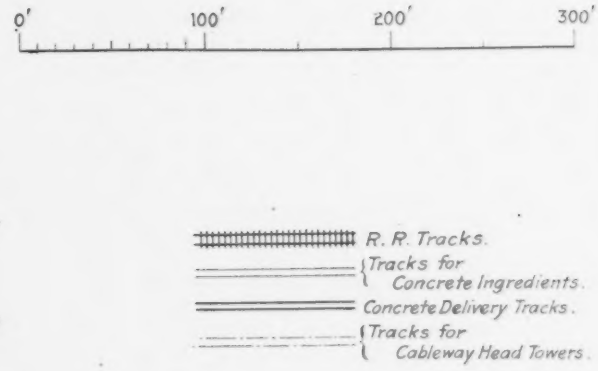

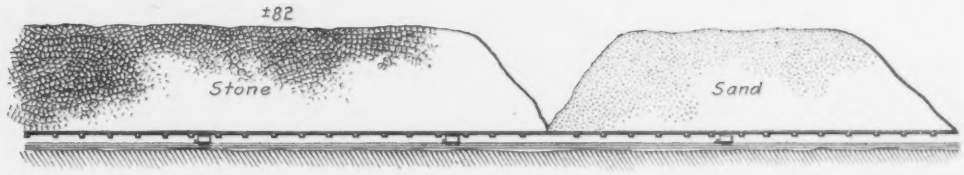

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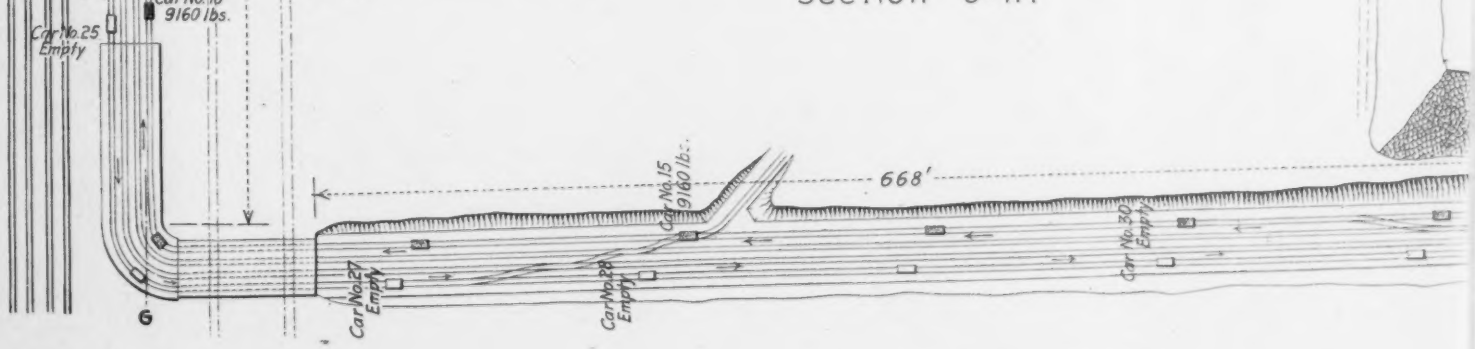
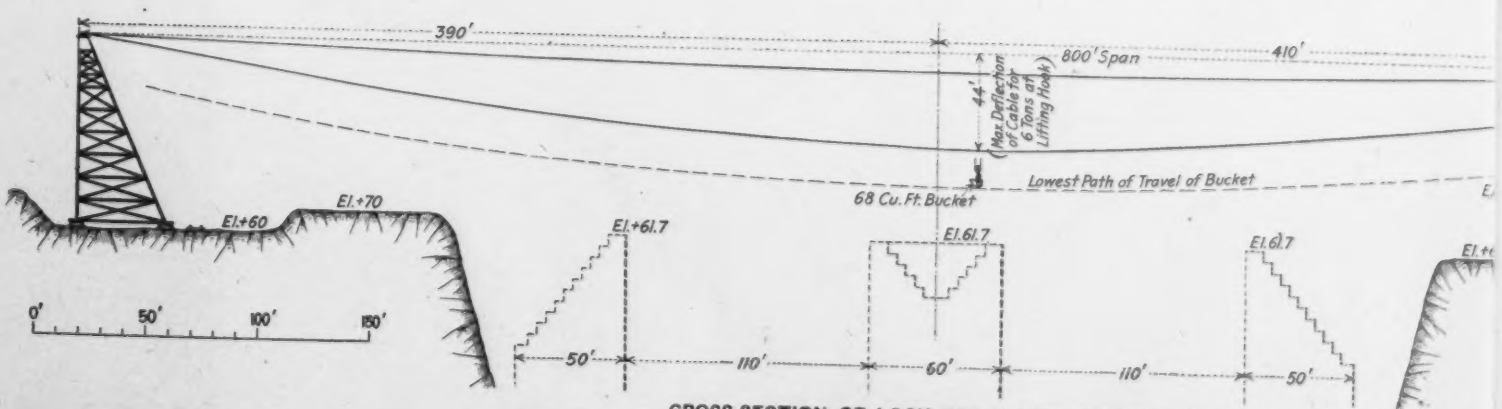
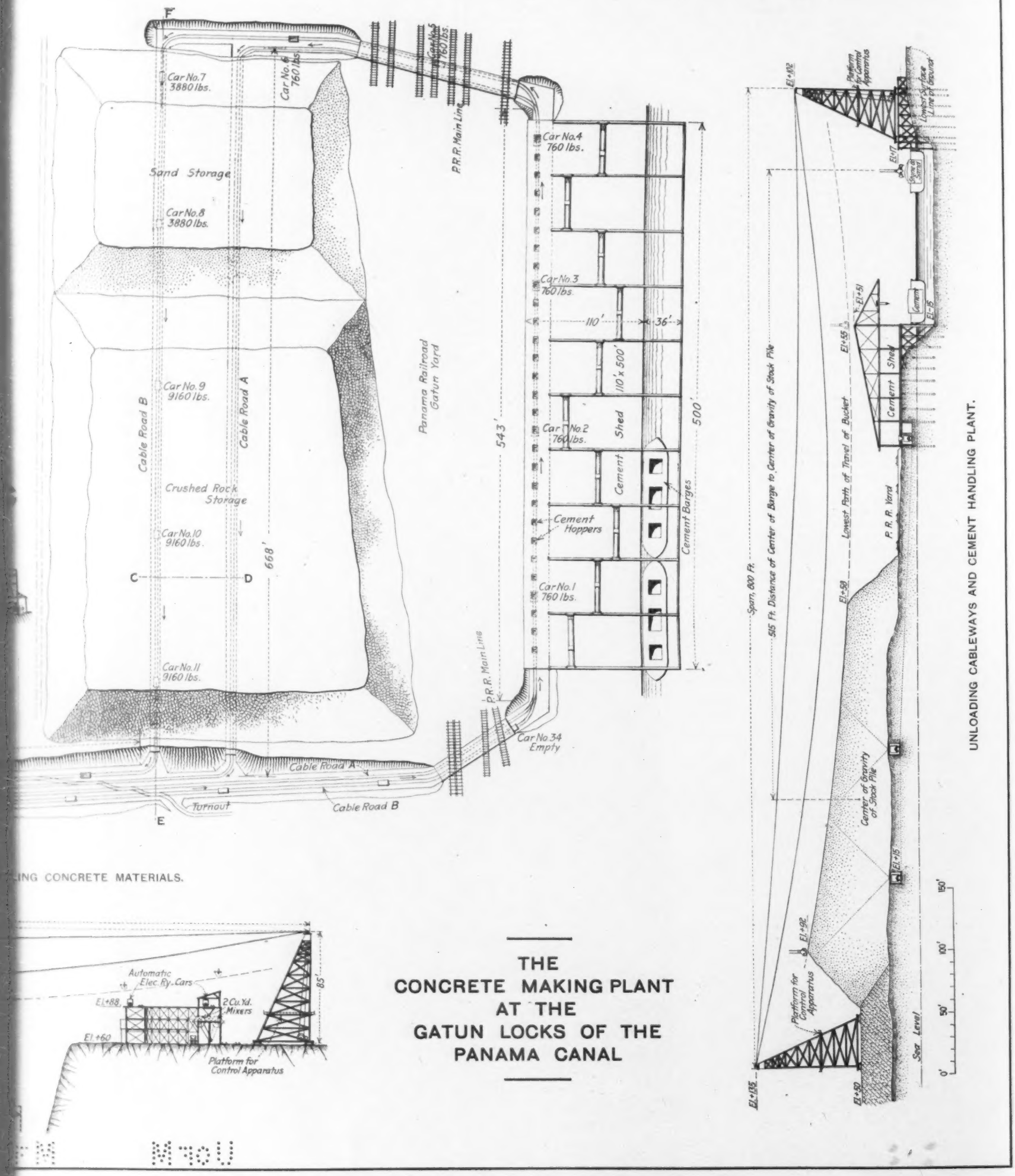


GENERAL PLAN OF PLANT FOR ASSEMBLING CONCRET



CROSS-SECTION OF LOCK PIT, SHOWING CABLEWAYS.



UNLOADING CABLEWAYS AND CEMENT HANDLING PLANT.

ING CONCRETE MATERIALS.

THE CONCRETE MAKING PLANT AT THE GATUN LOCKS OF THE PANAMA CANAL

ENGINEERING NEWS

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TABLE OF CONTENTS.

	Page.
LEADING ARTICLES:	
The Construction Plant for Gatun Locks and Gatun Dam (illustrated); Edward Schildhauer and Ernest Eugene Lee	183
Designing Concrete Abutments for Steel Highway Bridges (illustrated); H. E. Bilger	190
The Moodie "Selector" for the Separation of Fine Material (illustrated)	191
A Pumping-Irrigation Project with a Central Power Plant (illustrated); Robert P. Woods, M. Am. Soc. C. E.	192
A Bamboo Arch Bridge in Java, Dutch East Indies (illustrated); W. G. Bligh.	195
A Through Reinforced-Concrete Arch Bridge (illustrated); E. A. Gast	196
Pennsylvania Coal Mining in 1909	197
Skew Abutments for Deck Plate Girders on the Western Maryland R. R. (illustrated)	198
Improvement of the Port Facilities of Philadelphia	198
City Transportation Problems; A Report by Bion J. Arnold on the Pittsburg Situation (illustrated) [*Concluded*]	203
Reinforced-Concrete Pressure Pipe on the Umatilla Project, Ore., U. S. Reclamation Service (illustrated)	208
Depositing Concrete by Gravity Chutes for Building Construction	210
Fourth Annual Meeting of the Indiana Sanitary and Water-Supply Association.	211
Reasons for Public Development and Control of Water Power in New York State	211
A Bridge Collapse Caused by a Remarkable Abutment Failure (illustrated); Cornelius M. Daily	212
A Large Series of Full-Size Eyebar Tests	212
EDITORIAL	199
A Federal Bureau for the Inspection of Locomotive Boilers—The Concrete Arch with Horizontal Tie.	
A Bill to Increase the Cost of Advertising	199
The Plant for Building the Gatun Locks at Panama	200
LETTERS TO THE EDITOR	201
The New York City Water Department and the Forced Resignation of Deputy Commissioner Bemis; "Engineer"—An Official Statement Regarding Progress and Increased Efficiency in the Department of Water Supply, New York City; I. M. deVarona—On the Question of Licensing Civil Engineers; J. B., Eugene Hunt, Arthur W. Clemo, H. L. Handley, Pittsburgh M. Am. Soc. C. E.—What is the Best Pipe for Laying in Salt Ground? Oscar Ribeiro—Notes and Queries.	
ENGINEERING NEWS OF THE WEEK	213
PERSONALS	214
ENGINEERING SOCIETIES	214
ENGINEERING LITERATURE SUPPLEMENT	17

The Construction Plant for Gatun Locks and Gatun Dam.*

By EDWARD SCHILDHAUER† and ERNEST EUGENE LEE.‡

The object for which the Gatun construction plant was designed and constructed was primarily to unload, transport and mix the ingredients for concrete, and to place the same as used in the construction of the floors and walls of the lock chambers of the Gatun locks of the Panama Canal, and further, to transport the material used in the hydraulically filled portion of the Gatun Dam.

The entire plant is essentially an electrically driven one, with the exception of the dredges and the two auxiliary mixers. The system also includes the steam generating station and substation, which furnish, in addition to the current for lock and dam construction, current for various municipal purposes in the towns of Colon and Gatun.

CONCRETE WORK IN PROGRESS ON UPPER LOCKS AND FOREBAY AT GATUN, SEPT. 16, 1910.

The design was governed and affected by the topography of the locality, and by local conditions, among which transportation of material by water is an important factor. The plant is divided into the following elements:

(1) Generating station, (2) rock and sand unloaders, (3) cement cranes and cement storage, (4) automatic electric railroad, (5) mixers, (6) electric industrial railroad, (7) concrete depositing plant, (8) lock wall forms, (9) Gatun Dam dredging plant.

GENERATING STATION.—It is proposed to have completed all the construction work in about five years, when the entire plant will have served its purpose. The site chosen for the generating station was therefore based upon the immediate load demands, influenced by the supply of circulating water; it being proposed that energy for the operation of the locks be ultimately obtained from a hydro-electric plant to be built near Gatun Spillway.

To economize space and lessen operating costs, the substation equipment was installed in the turbine room, and throughout the entire design the fundamental idea was to give maximum latitude and ease of operation with minimum service requirements.

The turbine room contains the generators, and

*From a paper presented by the authors as a thesis for an advanced degree. Published in Engineering News by permission of Col. Geo. W. Goethals, Chairman and Chief Engineer.

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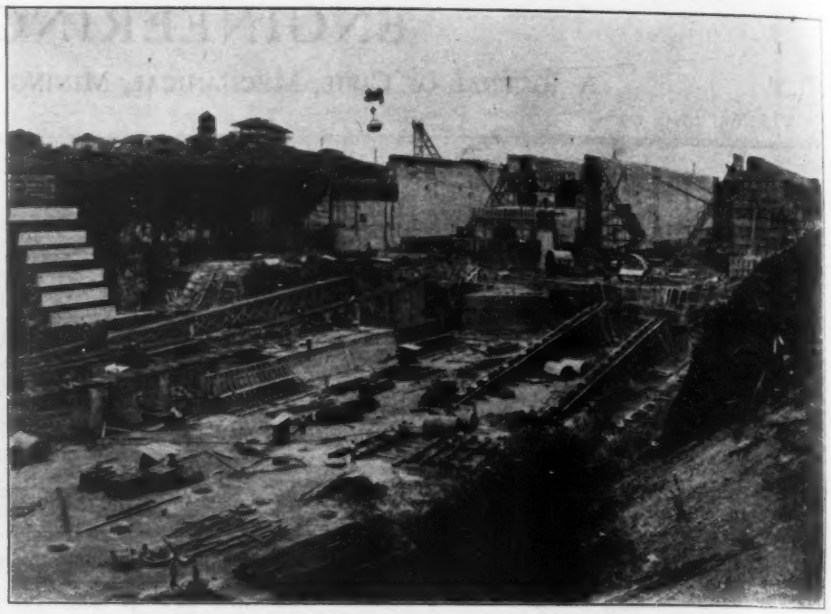
View of Lock Cableways at Work on Upper Lock from West Bank, Oct. 15, 1909.



Nearer View of Upper Locks, from West Bank, Oct. 15, 1910.

A YEAR'S PROGRESS ON THE UPPER GATUN LOCKS.

all of its steam and electrical auxiliaries, except the steam-driven automatic hot well pumps and the low-service oil pumps, all of which can be observed from the operating floor and are easily accessible therefrom for operation. The turbine auxiliaries are grouped on the throttle side of the turbine, so that one turbine operator only is required to start, stop or operate any unit. All of the electrical equipment was furnished by the General Electric Co.

The boiler-room, in addition to the boilers, induced draft system, and the lubricating oil storage and filter tanks, contains in one end a transformer room for three 100-KW. set-up transformers, supplying the Colon transmission line. All the boiler-room equipment was furnished by the D'Olier Engineering Co., of Philadelphia, Pa., but the boilers were manufactured by the E. Keeler Co., of Williamsport, Pa., and equipped with Foster superheaters, manufactured by the Power Specialty Co., of New York.

To insure the uninterrupted supply of fuel oil, in case of accident to an oil tank or oil piping, the system is installed in duplicate. The supply tanks are of about 250,000 gallons capacity, installed about 2,000 ft. from the plant and at about 60 ft. higher elevation. The oil is supplied to the burners under this head. The boiler is provided with ash pits, built of reinforced concrete under each boiler, in the basement. This is an emergency measure only, as ordinarily California fuel oil is used.

This basement also contains the main and auxiliary steam header, blow-off header, hot and cold water feed lines, and fuel oil header, with attending oil meters.

Current is supplied to the various elements of the plant by either alternating current or direct current feeders. The alternating current feeders that supply the relay pumps, lighting system, transmission lines, and various remote alternating current power motors are run overhead, while the automatic railway, and all direct current feeders are run underground. The underground feeder cables are lead and jute covered, and merely laid in the ground 18 ins. below the surface, with a board over them and then covered with earth.

ROCK AND SAND UNLOADERS.—The rock and sand is unloaded, elevated, conveyed and deposited from the barge in the slip to the storage pile about 600 ft. away, by means of two duplex and one single cableway, manufactured by the Lidgerwood Manufacturing Co., operating grab buckets of 2-cu. yd. capacity, manufactured by the Brown Hoisting Machine Co. These cableway towers are free to move on their tracks, parallel with the axis of the slip, by means of a winch on the tower, winding up a cable fixed to the dock.

The equipment is all electrically driven. All the operating machinery is mounted in the head towers, under the vigilance of one attendant, but remote controlled, the operator being stationed 800 ft. away on the tail tower, where he can obtain a perfect view of the barge. Hoisting and traversing motions are obtained by independent cables, each driven by an independent motor.

One strand of a duplex cableway is capable of unloading and transporting to the storage piles 60 cu. yds. of rock per hour, the traversing speed being 1,600 ft. per minute. The single cableway is used for sand unloading, and the two cableways for rock.

That the plant may operate continuously, each main cable is illuminated at night by one 18-in. searchlight projector, installed on the tail tower. The projectors are equipped with 20° diffusion lenses, and are supplied with current by a constant-current motor-generator set installed on the same tower.

In the event of the failure of the supply of material by barges, the stock in storage piles is reclaimed.

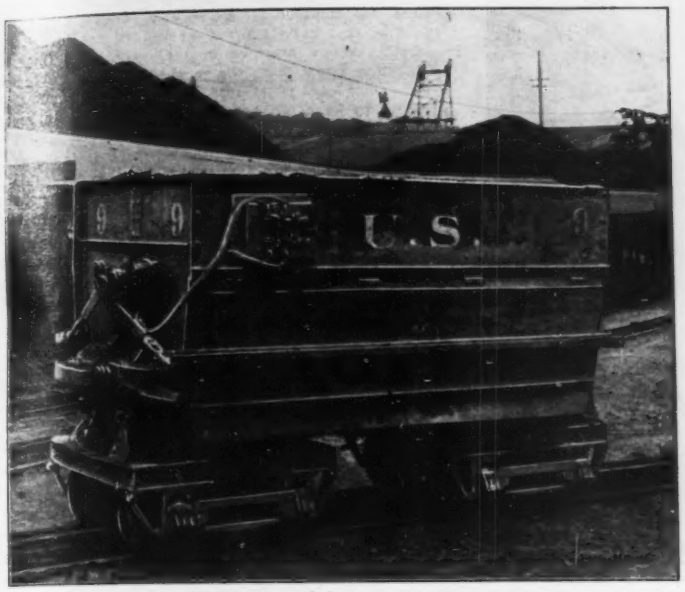
CEMENT CRANES AND CEMENT STORAGE.—The cement storage is on the side of the slip opposite to the unloading tail towers. The building is a frame structure divided into ten bays, each one of which is equipped with a crane, having a span of 47 ft. and a run of about 100 ft. The roof projects beyond the face of the dock to provide protection for the unloading barges and on these cantilever roof trusses the cranes run directly over the barge. The capacity of the cement storage is about 100,000 barrels.

On the main floor of the storage, and on the side opposite to the unloading dock, there are 30 cement hoppers covered with stable steel screens, into which the cement barrels or bags are emptied. The charge of cement is measured by the barrel or bag in the hoppers, each of which holds two barrels of cement. The cement is drawn thence to cars passing under the hoppers as hereinafter described. The empty barrels are

THE CONCRETE MIXING PLANT AT GATUN LOCKS, SHOWING CONCRETE CARRYING TRAIN.

taken by a conveyor running longitudinally with the building on the main floor, and discharged a short distance away from the building on a fire heap. To expedite the unloading of the cement steamers making delivery, the building is profusely illuminated, so that night work can be carried on efficiently.

AUTOMATIC ELECTRIC RAILROAD.—The distance from the rock, sand and cement storage



AUTOMATIC ELECTRIC DUMP CAR FOR CARRYING CONCRETE MATERIALS TO THE MIXERS.

to the mixer building is over 2,000 ft., and the latter is 61 ft. higher. The automatic electric railroad transports the concrete ingredients from storage to the mixer building. The road is automatic insomuch as the cars run without attendants. The cars are stopped, charged and started by the attendants at the respective storages.

In a similar manner the cars are emptied after arrival at the mixer building into charging hoppers above the mixers. The track from storage to mixers and return is a closed loop, and double-tracked except over the mixer charging hoppers, and under the cement hoppers, where all cars run on a common track.

The double looped track mentioned passes under the stone and sand storage piles through tunnels. The tracks are separated considerably for sake of greater storage capacity. The cars travel in a counter-clockwise direction, receiving first cement, then sand and rock. In the event of a blockade on one track, cars can be operated over the other. One track only is required for full plant capacity.

The system is 3-phase with under-running current rails. The cars when empty return down the incline, which has a minimum grade of about 10%, the motors running as generators, returning current to the line, and without use of mechanical brakes, except in case of failure of the supply of current, when the mechanical brakes are automatically set, and the cars brought to rest. A 2-pole, double-throw, carbon-break, knife switch mounted on the car body, connects the two motors of each car to the line and the car comes up to speed without the use of starting compensators. The speed of the cars is 300 ft. per minute, and under ordinary operation the cars are run at intervals of about 50 ft.

This equipment was furnished by the Atlas Car & Foundry Co., of Cleveland O., but the car motors are of Westinghouse manufacture.

CONCRETE MIXING PLANT.—The mixing plant consists of eight 64 cu. ft. capacity cubical mixers, manufactured by the Municipal Engineering & Contracting Co., of Chicago. The mixers are driven in sets of two from a jack-shaft. There are four jack-shafts, which are each directly coupled to a 75-HP., 25-cycle, 3-phase, 440-volt induction motor. The mixers are belt driven, having a tight and loose pulley.

The material from the hoppers above is admitted to the mixers by means of a segmental valve. This valve, together with the water-supply valve and the dumping lever, are all controlled by the attendant on the mixer floor. The quantity of water supplied is automatically measured.

The elevation of the mixers is such that the mixed material can be dumped into buckets on the industrial railway flat cars while on their normal track elevation.

ELECTRICAL INDUSTRIAL RAILWAY.—This system conveys the mixed concrete from the mixer building axially along the lock site, practically in a straight course to the lock cableways, which may be 2,000 ft. distant from the mixer building, in either direction.

There are four tracks, each one of which will run to both ends of the lock site. This amounts to a double track in each direction and allows great freedom in the movement of trains. The general method is to run the trains in circuit. To insure minimum maintenance of roadbed and minimum work about the third rail conductor, the roadway is ballasted with crushed rock from 9 to 12 ins. in thickness.

The trains consist of two flat cars and an electric locomotive, each flat car outgoing having a full bucket of concrete and a place to receive the empty bucket with which it is to return. The car lengths have been so designed that a train may receive two batches of concrete from the mixer at one spotting—the center to center distance of mixers and of cables on towers being equal.

This equipment was furnished by the Atlas Car & Foundry Co., of Cleveland, O., but the locomotives are of the General Electric Co. manufacture. The locomotives are of the regular, single truck, four-wheel mine locomotive type, with series-wound railway type motors for 550 volts direct current—two motors per. locomotive. During regular operation a locomotive hauls two loaded buckets on a minimum grade of 2.1% at ten miles per hour. The current is supplied by an outside under-running third rail.

CONCRETE DEPOSITING PLANT.—This plant is quite similar to the unloading cableways, and consists of four duplex cableways which span the lock-site, a width of 800 ft. The plant was furnished by the Lidgerwood Manufacturing Co., of New York, but the electrical appliances and motors were manufactured by the General Electric Co. A single strand of any tower is capable of handling a weight of six tons, and in addition to depositing concrete they are used for handling forms and placing fixed irons for masonry.

The operation is arranged for remote control, but the operator in this instance is stationed on the same floor as the operating machinery. The braking for inhaul and outhaul is done pneumatically, while braking in lowering is done dynamically.

GATUN DAM AND DREDGING PLANT.—The larger part of Gatun Dam will be placed hydraulically between the two toes of the dam, which are composed of rock and miscellaneous material obtained from steam shovel excavation along the canal. The interior portion is formed of a natural mixture of sand and clay dredged from the lowlands, in amount about 10,000,000 cu. yds.

Two 20-in. suction dredges are excavating this material on the lower side of the dam, at mean sea level. Two 20-in. suction dredges excavating on the upper side of the dam are operating at elevation plus 14.

The maximum elevation to which some of this material must be pumped is 115 ft. above sea level. To accomplish this end, relay pumps are installed in the dredge discharge line.

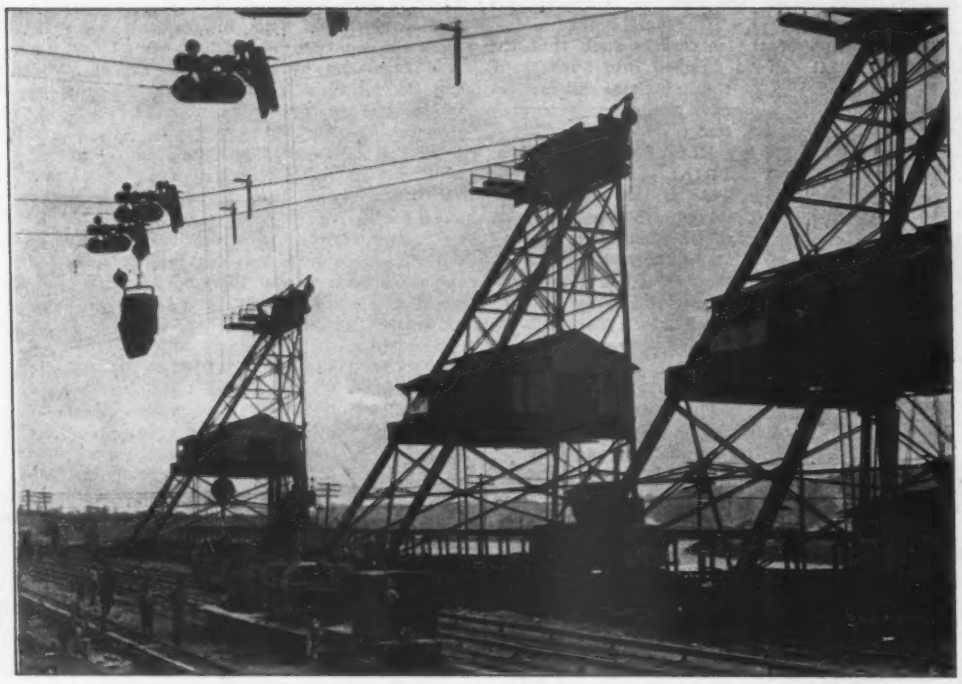
[The detailed contract specifications for the various parts of the plant which here follow in the original paper, occupying over a hundred pages, are necessarily omitted here.—Ed.]

Generating Station Organization.

STATION ENGINEER.—The Station Engineer should be a technical graduate, with a thorough knowledge of the operation of the steam apparatus and a practical knowledge of the operation of the electrical apparatus. The duties of the Station Engineer cover a wide executive range with the fundamental requirements of continuous and economical production of current as a standard of reference. He shall have direct and responsible charge of the entire apparatus and operation of the turbo-generating station and also the rotary sub-stations through the respective subordinates as hereinafter defined, and shown on organization chart. He shall keep, or cause to be kept, a complete log and record of the entire combined and segregated electrical output of the station and sub-

AUTOMATIC ELECTRIC CARS RETURNING EMPTY ON 4.5% GRADE.

stations, the time of the force, the exact amounts of fuel consumed, water evaporated, and the charge of miscellaneous expenses incurred by the operation of the machinery, all of which shall be entered and recorded upon the station log sheets each day, that detailed and total



HEAD TOWERS OF CABLEWAYS FOR LOCK CONSTRUCTION. WITH ELECTRIC TRAINS FOR BRINGING CONCRETE.

costs may be determined per unit output of the plant, daily, monthly and annually.

When the Station Engineer is a thoroughly capable and competent electrical operating man, to him shall report the switchboard operator and the foreman of the outside electrical force through the Assistant Station Engineer. In this case the Assistant Station Engineer must be a man thoroughly qualified to supervise the operation of the steam end of the station in detail, i. e., turbine and boiler room and auxiliaries.

ASSISTANT STATION ENGINEER.—To be preferably a technical graduate with a thorough knowledge of operating and testing electrical apparatus, and a practical knowledge of operating the steam apparatus. His duties embrace the supervision of the entire operating force, and the responsibility for the proper operation of the station as a whole. He must circulate among the different installations, noting any irregularity in the operation of the machinery or in the men on the different watches, and keep his superior in touch with such details as do not come under the immediate notice of the latter. In the absence of the Station Engineer he shall act in the latter's capacity.

FIRST WATCH ENGINEER.—The First Watch Engineer shall be a licensed stationary engineer and be in direct charge of the turbines and auxiliary apparatus and the boiler-room equipment. It shall be his duty to cut in and out of service the units as they may or may not be required, and to know at all times what units, both electrical and steam, are ready for service. He shall keep in touch with the Switchboard Operator so as to know the exact conditions of load. He shall give operating orders during normal conditions to the Switchboard Operator.

SECOND AND THIRD WATCH ENGINEER.—The qualifications and duties of the Second and Third Watch Engineers shall be the same as the First Watch Engineer for their respective watches, except that they shall report through the First Watch Engineer to the Assistant Station Engineer.

ASSISTANT WATCH ENGINEER.—The Assistant Watch Engineer (unlicensed), shall report directly to the engineer of his watch. His duties shall be to keep a vigilant watch over all turbine operating and their auxiliaries, to note any disorder or irregularities in the operation of apparatus under his care and to assist the Watch Engineer in cutting units in and out of service.

FIREMAN.—Under the direction of the Watch Engineer the duties of the Fireman are to be the proper operation and maintenance of the boiler-room apparatus, including the attention required by the induced draft fan equipment, all the valves and steam lines in the boiler room, also the starting and stopping of steaming of boilers and the correct manipulation of boiler-room valves and the boiler-feed pumps.

ASSISTANT FIREMEN.—Shall report to the Fireman. They shall assist the Fireman in the capacity of Water Tenders and such other duties as may be assigned.

MACHINIST.—The Station Machinist must be capable of making immediate light repairs to valves, piping, pumps, engines and other station accessories, also packing of stuffing boxes and glands, grinding of valve seats, and other general maintenance.

WASHERS.—The Boiler Washers shall report directly to the Firemen. It shall be the duty of the Boiler Washers to wash such boilers as directed.

OILERS.—The Oilers are required to keep the motive power in operation after it is started, and to know that the lubrication of each machine in service is properly performed. In case of any irregularity in the operation of turbines or auxiliaries, the Oiler is to give immediate notice, in the first watch to the First Watch Engineers and in the second and third watches to the Assistant Watch Engineers, or in emergency to the engineer in charge. He is also required to see that machines do not use too much lubricant, and when a unit goes off the load, to clean it ready for the next run. They are required to render such services not only as will keep the machine in service and attractive to the eye, but render such assistance as may be required in the work of the Watch Engineers and their subordinates.

SWITCHBOARD OPERATOR.—The duties of the Switchboard Operator are to be the controlling, oiling, cleaning and testing of the generators, rotaries and rotary auxiliaries, motor exciters, oil switches and switchboards. The Switchboard Operator shall tabulate as required, the loads on all electrical apparatus, and record the time that units are cut on and off the load. The operating orders executed by the Switchboard Operator shall come direct from the respective Watch Engineers. The Switchboard Operators of the second and third watches to have the same qualifications, but to report through the Switchboard Operator of the first watch.

WIREMAN.—The duty of the wireman is to be thoroughly familiar with the station wiring, and capable of making repairs and renewals to electrical equipment in the station, and assist the Switchboard Operator in tests when required.

STATION RECORDER.—The duties of the Station Recorder shall be to compile all load records, plot curves, keep time, station accounts and perform all general clerical and correspondence work of the station.

Outside Electrical Force.

FOREMAN.—The Foreman of the Outside Electrical Force is to have direct charge of the maintenance of electrical equipment, including lighting, transmission lines, distribution system, both direct-current and alternating-current, up to and including all the motors on the system.

Plant Operation.

The divisions of plant organization are made along lines which coincide very closely with the elementary plant division. A foreman is in charge of each particular element, all of whom report to one man in charge of the entire plant. In the generating station there are three shifts of eight hours each, while for the remainder of the elementary plants, for operating, there are two shifts of six hours each, except the relay pumps which have the same arrangement as the station.

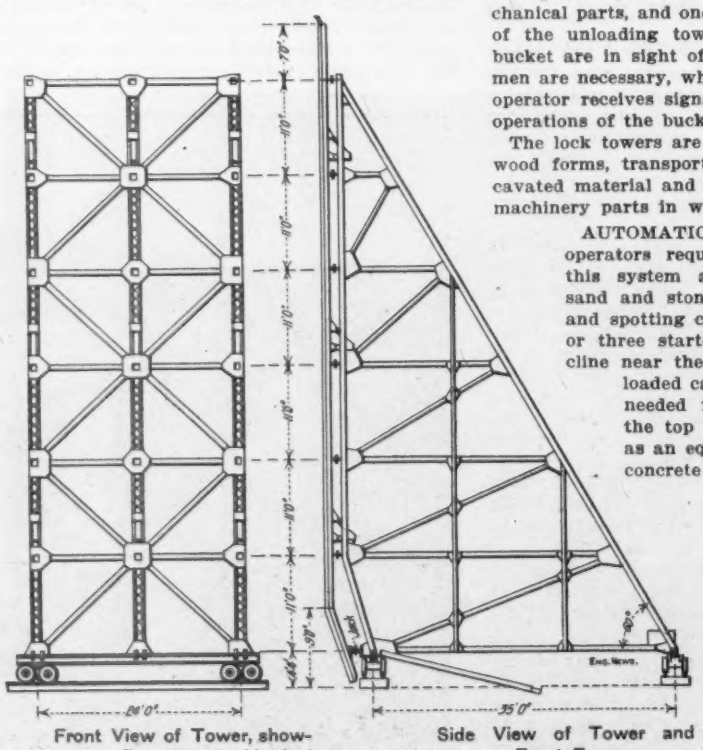
GENERATING STATION.—The operation of the generating station may be best outlined by referring to generating station organization, and the chart therein referred to.

CABLEWAYS.—There is one operator for each single cable. In the machinery rooms of these towers there is one white attendant who looks after the general condition of the machinery and its operation, including all electrical and mechanical parts, and one colored oiler. In the case of the unloading towers, all operations of the bucket are in sight of the operator and no flagmen are necessary, while in the lock towers each operator receives signals from a flagman for all operations of the bucket when out of his sight.

The lock towers are used for placing steel and wood forms, transporting skips loaded with excavated material and for moving gate parts and machinery parts in weight up to six tons.

AUTOMATIC RAILWAY.—The only operators required for the operation of this system are those at the cement, sand and stone valves and for dumping and spotting cars in the mixer, with two or three starters at the foot of the incline near the mixer building where the loaded cars are held in reserve until needed in the mixer building, at the top of the incline. This serves as an equalizer and the demand for concrete can always be met. Practically all of the laborers used on this work are colored (a few European laborers excepted), with a white foreman. During normal operation one car can make a little over three trips per hour, which is equivalent to six cu. yds. per car per hour or better.

LOCK WALL FORMS.—The lock wall forms are placed and cared for by various crews, the num-



Front View of Tower, showing Front and Vertical Bracing.

Side View of Tower and Front Form.

STEEL FORMS FOR GATUN LOCK WALLS.

hor depending entirely upon the nature of the portion of the wall building and the rapidity with which concrete is being laid.

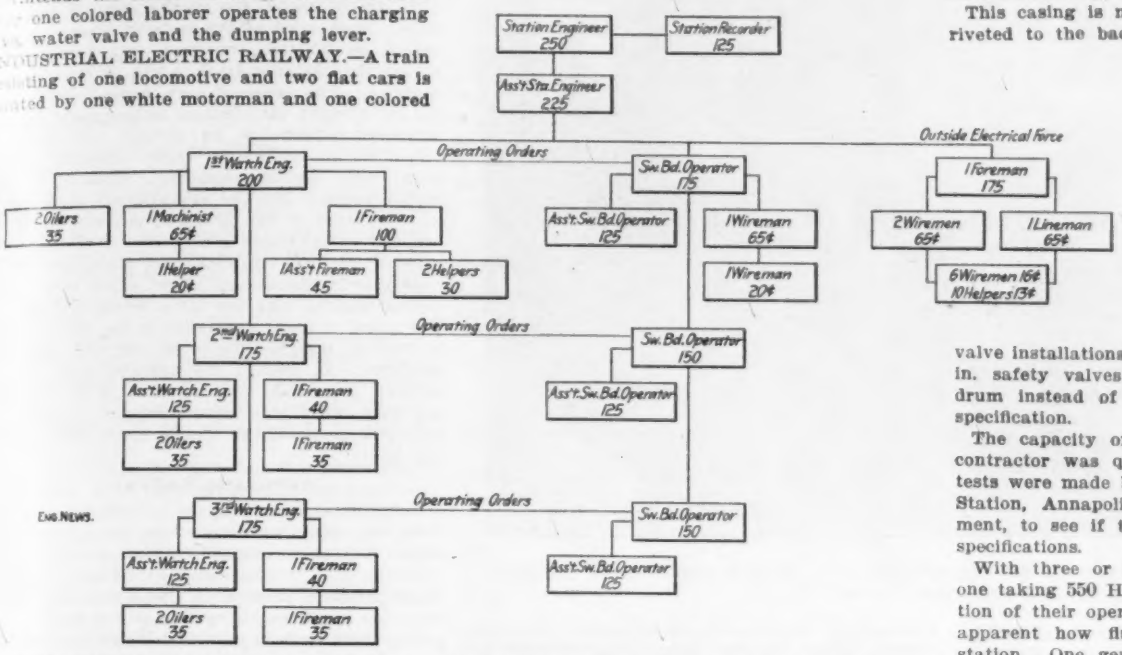
OPERATING COSTS.—It is the intent or purpose of this paper to give operating costs of power generation only, and labor as included therein. Practically all labor in the station is white. The class of labor used throughout the handling pit is practically all colored and is by no means efficient, and operating figures which could be given based upon this labor would be misleading. It was considered advisable to give such figures as could best be used to advantage.

CONCRETE MIXERS.—One white foreman superintends the mixer building, while for each mixer one colored laborer operates the charging valve, water valve and the dumping lever.

INDUSTRIAL ELECTRIC RAILWAY.—A train consisting of one locomotive and two flat cars is operated by one white motorman and one colored attendant. A signal man at the mixer building spots the trains to receive their load. At the lock cableways another attendant helps the train attendant fasten and unfasten the trolley hook. The train attendant cleans the bucket while on the return route to the mixer.

TRAVELING CRANES.—The cement shed traveling cranes are manipulated by one white operator, the necessary colored laborers hook, unhook and store the barrels.

RELAY PUMPS.—The relay pumps have one white attendant at all times, there being three eight-hour shifts on this service. The pumps are remote-controlled from the dredge, so the attendant's service is to oil and inspect exclusively.



ORGANIZATION AND MAXIMUM RATES OF PAY OF OPERATING FORCE AT GATUN AND MIRAFLORES POWER STATIONS, PANAMA CANAL.

Discussion.

GENERAL.—Despite the fact that operations at Gatun are very much centralized as compared with the remainder of the work on the Panama Canal, the various elements of the Gatun construction plant are or will be sometime during the construction period distributed over an area one-half by two and one-half miles. Since some of the elementary plants are of a semi-stationary character and require power constantly, it has been considered uneconomical to have each plant furnish its own power. In the installation of a plant for construction purposes, many managers advocate installing cheap machinery and on the whole make a cheap installation, the argument presented being that it is economical to do so for the plant is used only a short time—five or ten years—and then discarded, low first cost being considered economy. It is in just such problems that great care and judgment should be exercised, and competent engineering skill should be consulted, for in the plant's first cost, what seems to be a saving may be converted by inefficiency into a loss.

Generating Station.

The argument in the preceding paragraph applies to a generating station more forcefully than to a construction plant as a whole, as a brief calculation will soon demonstrate.

The present monthly output of the Gatun station is about	1,000,000 KW.-hrs.
Present cost at switchboard of Gatun station, less than	1.5 cts. per KW.-hr.
A non-condensing plant of 400-HP. units—unit cost at switchboard from actual figures, is more than	3.0 cts. per KW.-hr.
The difference in favor of the modern station is	1.5 cts. per KW.-hr.
1,000,000 KW.-hrs. at 1.5 cts. saving	$15,000 per month saving

Considering the cost of the present plant installed (neglecting the building and substation, which would be common to both) as $250,000, the plant would pay for itself in a period of about 16.5 months, or in five years the plant would earn its cost 3.6 times.

The selection of the kind of current to be used in a plant of this character is a question of considerable moment, and in this particular case received extended discussion.

Since under certain conditions reserve steam plant is essential and as some of the apparatus used for construction purposes can also be used for the permanent operation of the canal, the requirements of the future installation for the completed canal influenced the decision in a large degree.

BOILERS.—The inherent inefficiency of an all brick boiler setting has always been annoying, both to the operating engineer and power station manager. Modern practice demands that great pains be exercised to obtain a setting which shall crack as little as possible to minimize the air leaks.

In this installation another factor affecting the life of the boiler setting as well as the boiler efficiency had to be considered, and that was the proximity of the plant to blasting activities. It was therefore decided to specify boilers of the steel encased type.

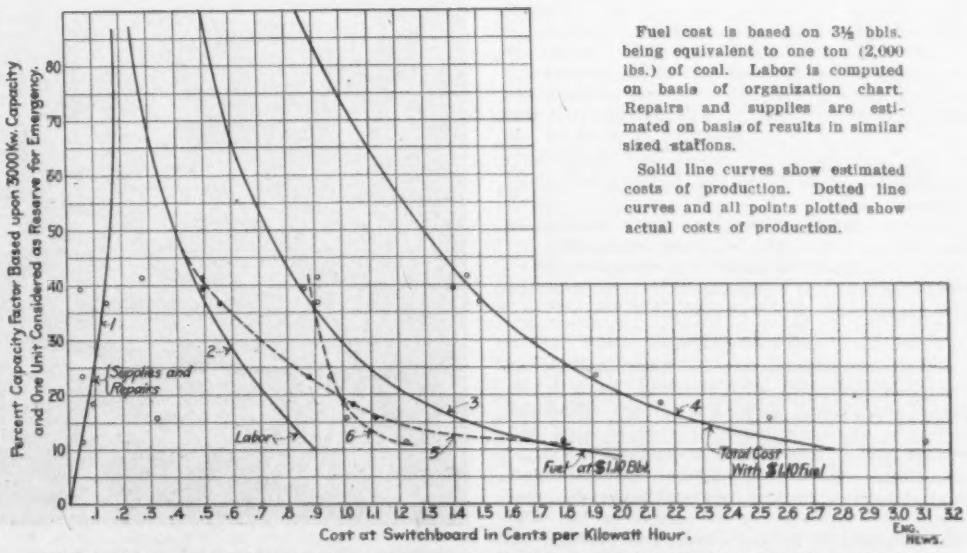
This casing is made practically air-tight, and riveted to the backstays. Inside the steel is a 2-in. layer of asbestos block, then the inner wall of 8-in. fire-brick, where required, is anchored to this casing. This provides a setting which is practically flawless, and in a large measure is considered responsible for the high boiler efficiency obtained in the acceptance tests.

SAFETY VALVES.—With regard to the safety-valve installations it is to be noted that two 3½-in. safety valves are mounted on each steam drum instead of one 5-in. as covered by the specification.

The capacity of the valves furnished by the contractor was questioned, whereupon complete tests were made by the U. S. Naval Experiment Station, Annapolis, Md., of the Navy Department, to see if these valves complied with the specifications.

With three or four dredge relay pumps each one taking 550 HP., and with frequent interruption of their operation for various reasons, it is apparent how fluctuating is the load on this station. One generator may supply current to the relay pumps of two dredges, which at present are three in number, and later will be four. A shut down of two dredges with four relay pumps would mean the total reduction of load on one generator and two boilers. In such case should a safety valve fail to operate, two valves still remain for protection, there being one on the superheater and one on each of the steam drums.

Instead of giving a detailed specification of the operating lift for safety valves as was done in this instance, the results might have been obtained in another manner by specifying as follows: "Safety valves shall be provided which shall have sufficient relieving capacity that should the boiler be steaming at 50% over build-



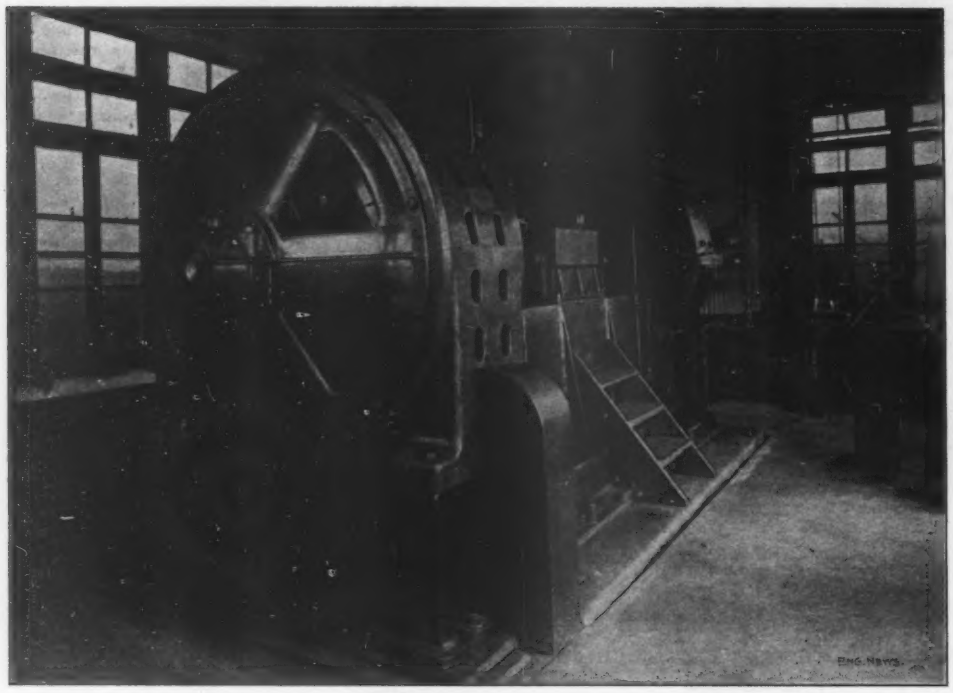
Fuel cost is based on 3½ bbls. being equivalent to one ton (2,000 lbs.) of coal. Labor is computed on basis of organization chart. Repairs and supplies are estimated on basis of results in similar sized stations.

Solid line curves show estimated costs of production. Dotted line curves and all points plotted show actual costs of production.

DIAGRAM SHOWING ITEMIZED COST OF POWER GENERATION IN GATUN POWER HOUSE, ESTIMATED AND ACTUAL.

er's rating, the boiler pressure shall not be raised to exceed normal boiler pressure more than ten pounds." This feature could, of course, be easily tested after installation. The same number of valves, the locked up feature and requirements of this character should be specified as before.

SUPERHEAT.—These boilers with their superheaters were designed to give superheat of 150° F. It was determined under Test 1, of Nov. 17, 1909, as given in Tests XII., that the average superheat for a ten-hour run was only 43.4°. Investigation developed two places that might be charged as accountable for low superheat; first, the dry steam-pipe was not properly designed and installed, and second, the brick baffler in the first pass needed modification.



CENTRIFUGAL RELAY PUMP DRIVEN BY 550-HP. ELECTRIC MOTOR FOR RAISING DREDGED MATERIAL FOR DELIVERY ON GATUN DAM.

DRY-STEAM-PIPE.—The installation had the dry-steam-pipe equally divided by the vertical connection to the saturated steam nozzle, one-half forward and one-half back. When forcing the boiler the great agitation of the water over the front water leg caused foaming, the divided particles of water passing into the dry-steam-pipe also absorbing some of the superheat. For the dry-steam-pipe described, one of equal length was substituted, the entire length of which was back of the saturated steam nozzle. This places the collecting of steam back of the turbulent point of water circulation in the steam drum.

BAFFLER MODIFICATION.—The design of the baffler furnished provided for an opening the entire distance across at the bottom of the tubes and about 4 ins. high. It was thought that this allowed a large short-circuiting of some of the hottest gases from the superheater, whereupon the opening was closed in a semi-permanent manner.

After the modifications were made, the test of Dec. 8 and 9 was run with the result that the average superheat of steam was raised to 106.5°, while the average temperature of the escaping gases from the boiler was only 11.5°.

Cableways.

In this installation, the cableway system, as previously described and specified, as a whole works admirably. However, a more efficacious system of unloading material, such as sand and crushed stone from barges to storage, could, in the opinion of the authors, have been provided. The present unloading system takes its material from the hatches of barges in the slip, elevates about 90 ft. and conveys to storage. A large storage is necessary, for "northers" sometimes occur, which delay sea traffic for a period of seven to ten days. A large storage is required in any case, the quarry being about 20 miles distant on the Atlantic coast. A scheme which would give more satisfaction, in the opinion of the authors, is herewith outlined.

This system would consist of a rock unloading pier with frame storage bins built thereon adjacent to the present cement shed. The unloading would be done from barge to bins by means of electric-driven revolving cranes. These pier bins should have a three-days' storage capacity.

Provision for greater storage capacity would be made by operating a double track automatic electric car loop system. These cars to run when delivering to storage under the pier bins, receive their load and thence on trestles over the storage pile.

Ordinarily, rock and sand would be taken from the pier bins by the automatic electric cars direct to the mixer building. When it is required to take material from the storage pile, in case of the pier bins being empty, the same electric cars in their cycle would pass through tunnels under the storage pile, thence to the mixers. Whether taking material from the pier bins or storage, the cars in their cycle would always pass through the cement shed. By the method last described all rock and sand, except that required for storage, would go direct from the pier bins to the mixer.

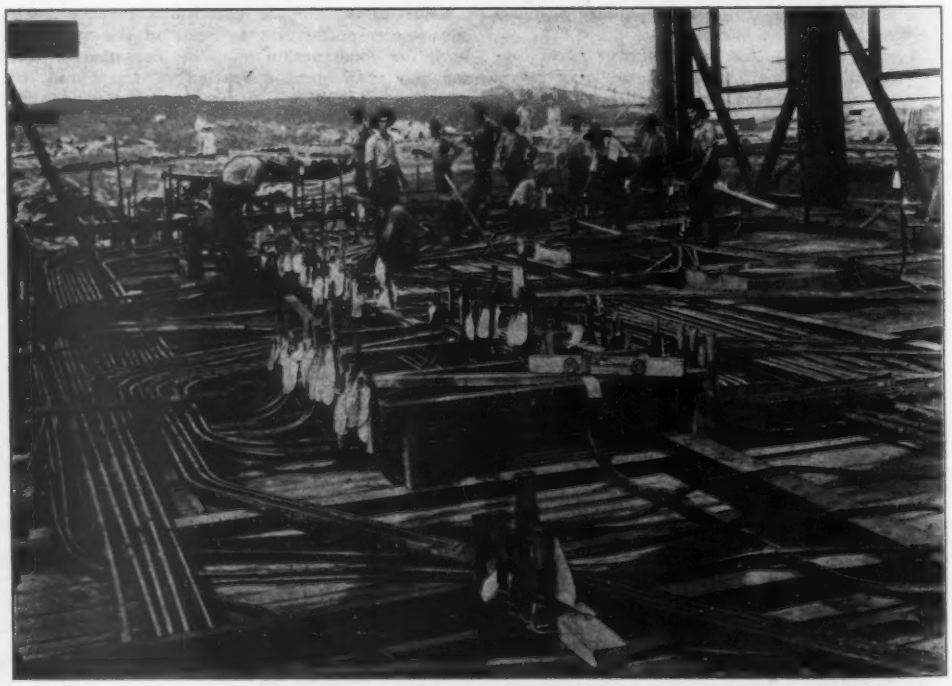
Estimates show that the proposed plant having a capacity equal to the present plant would be about equal in cost. The power consumption of the proposed plant would obviously be less than the present plant, for in the case of the proposed plant, most of the material when unloaded would be hoisted, conveyed only the distance across the unloaded track, about 20 ft., and then dumped. The cause of high power consumption in the present installation, as compared to the proposed scheme is on account of the high velocities of traversing, rapid acceleration and long hauls during unloading. Considering the maintenance of the two systems, the argument is also in favor of the proposed scheme, since the amount of operating machinery is reduced, the number of rope sheaves and amount of steel rope greatly diminished, all of which lessens the cost of upkeep, and less labor would be required. The point of great difference in the two systems is that of material delivered per unit time per machine. At present the average rate of continuous unloading sand or rock is 30 cu. yds. per hour, while from actual practice a rapid unloader as proposed can handle 120 to 200 cu. yds. per hour.

Automatic Railway.

The automatic railway as a unit is a success. However, since its installation, continuous operation has demonstrated where improvements could have been made in the original design in some details. In general, the space limitations were too small, requiring a gage too narrow, together with low trucks and small wheels. A more liberal gage would have been advantageous. The present 24-in. gage made a truck of cramped design, that caused perfect operation to be sacrificed at the expense of space requirements, and a 30-in. gage would have eliminated this. The car bodies and their method of dumping have proven, by their continued service, satisfactory.

Cement Unloading Cranes.

The specification stated that cement would be unloaded from the barges by the cranes picking



CONDUIT INSTALLATION AT GATUN POWER STATION READY FOR POURING OF CONCRETE FLOOR, APRIL 19, 1909.

up a loaded net, containing the barrels. It was soon found by trial that a much easier, simpler and more economical way was to use barrel hooks. Twelve barrel hooks are attached in pairs to ropes with a common place for attachment to the crane hook. This arrangement allows the picking up of six barrels lying in any position within a radius of 5 ft., without the handling that is required with a net.

When the barrels have been carried to the proper place in the storage shed, the load is lowered and one barrel hook loosened from each barrel and the carrier is free. The crane now returns to the barge, lowers the carrier, which is then taken from the crane hook, and a loaded one takes its place. One crane of this system will unload 300 to 350 barrels per hour. The crane is also used in the same manner to pick up barrels from storage and transport to the cement measuring bins located on the opposite side of the cement shed.

Generating Costs.

Before the plant was completed estimates of the cost of current at the switchboard were made by plotting the curves described below. For comparison the actual operating costs as obtained for this plant are plotted on the same sheet, as the estimated cost curves. The following general conditions governed the construction of these curves.

From theoretical load curves made after the class of apparatus to be used was settled upon it was estimated that the load could be carried nominally on two units, with a maximum capacity of 3,000 KW. the third unit to be held in reserve.

Therefore, a capacity factor on this assumption was selected as a basis from which to start, in preference to the load factor, as capacity gives a constant factor, and in addition takes into account more accurately the losses incurred in running the two units at various loads. The specific considerations for various elements in the different items making up the total cost were:

Curve 1. Repairs and Supplies.—These were allowed for at the rate of 0.19 cts. per KW.-hr., so long as the capacity factor remains above 60%. When the factor falls below this amount, spare time enough is afforded the operating force to effect ecomonies in the use of supplies and to make minor repairs and adjustments with a minimum of additional labor. The figure, 0.19 cts.. was selected from the costs obtaining in stations already in operation.

Curve 2. Labor for Operating.—This item was calculated for various percentages of the capacity factor from the pay-roll allowed by the authorized organization chart, allowing for a similar force when starting up the plant and increasing to a complete operating force as the load demanded it.

Curve 3. Fuel.—To arrive at a basic curve between various loads and cost at switchboard in cents per KW.-hr., data was taken from actual practice as given by some of the engineering associations and combined with personal engineering data. For this comparison the available data was converted to a fuel cost of $6 per ton (2,000 lbs.) and a heating value of Pocahontas coal. As fired in good furnaces, one ton of this coal was considered approximately equal to 3.5 bbls. of the oil as fired. It was not expected that the oil fuel costs would coincide with this curve at low percentages of capacity factor as no allowance has been made for the higher efficiency of oil as fuel at light loads, for there was no data at hand regarding the magnitude of loss incurred by the opening and closing of furnace doors in stoking coal furnaces. The operation of one boiler under overload or of two boilers under partial load will have a decided effect on this curve, which is governed only by operating conditions.

Curve 4. Total Cost at Switchboard.—This is the sum of the abscissae of curves 1, 2 and 3, for any given ordinate. It includes the depreciation of similar charges.

Comparison of Actual Results and Estimate.

Curve 1. Supplies and Repairs.—The points of actual monthly cost plotted about the estimated curve show this item to have been fairly estimated. A wide difference is to be expected from month to month, as repairs are made in one month running the cost per KW.-hr. high that particular month, while in another month no extensive repairs are required. As a matter of fact the cost of large repairs are really chargeable to more KW.-hr than those generated in the month during which repairs are made; doing this would average up the points more nearly to a smooth curve.

Curves 2 and 5. Labor.—This curve shows a wide variation from the estimate as the full force was employed from the start for sake of perfecting the organization while construction men were available to select from, and was not increased from a minimum to a full force as contemplated in the estimate.

Curves 3 and 6. Fuel.—The actual fuel costs fall much below the estimate for several reasons, namely, the higher efficiency of oil as fuel at light loads, the full operating force being able to watch carefully all points at which there might be prevention of losses, and the high boiler efficiency when operating under normal rating.

Curve 4. Total Cost at Switchboard—The actual costs fall fairly on the estimated curve for the most part. The two points at the lower portion show a higher cost on account of the high item of labor (curve 5) more than offsetting the lower cost of fuel (curve 6).

TABLE I.—CONCRETE HANDLED BY ELECTRIC-DRIVEN PLANT AND KW.-HR. USED BY ELEMENTARY PLANTS PER MONTH.

Month. 1909.	Cu. Yds. 1	KW.-Hrs. Auto. Ry. 2	Mixer. 3	Ind. Ry. 4	Lock Towers. 5
Sept.	11,364	13,710	5,580	8,050	24,150
Oct.	27,586	16,890	18,030	15,700	36,400
Nov.	30,270	23,150	18,297	17,415	43,583
Dec.	42,506	41,647	26,900	18,870	50,321
1910.					
Jan.	43,462	41,066	25,624	20,669	55,120
Feb.	43,670	32,528	28,121	23,782	57,387
March*	41,756	31,286	25,724	28,810	72,950
April*	44,272	34,470	27,574	34,059	82,942

*The relatively large KW.-hr. consumption of these two months with less yardage is accounted for by the fact that the cableways were used for cleaning up the lock pit by means of skips.

TABLE II.—TRANSPORTING, MIXING AND DEPOSITING OPERATION.

KW.-hrs. Used by Each Elementary Plant, Per Cu. Yd. of Concrete.

Month. 1909.	Auto. Ry. 1	Mixer. 2	Ind. Ry. 3	Lock-tower. 4	Total KW.-hr. 5	Unit Cost. 6*
Sept.	1.208	.492	.700	2.125	4.534	$0.251
Oct.	.614	.656	.571	1.320	3.161	.0995
Nov.	.756	.604	.575	1.438	3.382	.086
Dec.	.978	.625	.443	1.183	3.229	.069
1910.						
Jan.	.945	.590	.475	1.264	3.274	.063
Feb.	.745	.644	.543	1.315	3.247	.0472
Mar.	.750	.616	.686	1.745	3.797	.0572
Apr.	.780	.623	.770	1.875	4.048	.0562

*Col. 6 = Col. 5, Table II. × Col. 2, Table VII.

TABLE III.—CEMENT UNLOADING OPERATIONS.

Month. 1910.	Barrels handled. 1	KW.-hr. used. 2	KW.-hr. per bbl. 3
Jan.	21,429	1,370	.064
Feb.	39,226	3,060	.078
Mar.	36,320	3,080	.055
Apr.	67,988	4,490	.067
		Average	.066

TABLE IV.—ROCK AND SAND UNLOADING OPERATIONS.

Month. 1910.	Rock, cu. yds. 1	Sand, cu. yds. 2	Rock & Sand, cu. yds. 3	KW.-hrs. used. 4	KW.-hr. per cu. yd. 5
Jan.	32,106	6,726	38,832	55,120	1.420
Feb.	31,956	7,234	39,190	44,720	1.141
Mar.	29,249	11,465	40,714	49,723	1.222
Apr.	35,005	15,578	50,583	54,707	1.085

TABLE V.—SUMMATION OF COSTS OF POWER TO HANDLE MATERIAL FROM BARGES TO LOCKS, INCLUDING PLANT DEPRECIATION.

Month. 1910.	Cement. 1 cts.	Rock and Sand. 2 cts.	Trans. Mix and Deposit. 3 cts.	Constr. Plant Arbitrary. 4 cts.	Total. 5 cts.
Jan.	.127	2.735	6.3	60.4	69.562
Feb.	.096	1.670	4.7	60.4	66.866
Mar.	.100	1.850	5.7	60.4	68.05
Apr.	.092	1.517	5.6	60.4	67.609

1. Cost of power only for unloading the quantity of cement required (1 bbl.) for 1 cu. yd. of concrete on the basis of the average KW. per bbl. for the four months given, and switchboard cost as given in Col. 3, Table VII.

2. Cost of power only per cu. yd. for unloading rock and sand to storage.

3. Cost of power per cu. yd. to transport, mix and deposit concrete in lock-wall forms. This is the product of Col. 5, Table II., and Col. 3, Table VII., which includes the generating station arbitrary of $0.0088 per KW.-hr.

4. Construction plant depreciation arbitrary made on the basis of yardage is 60.4 cts. per yd.

5. Total cost of power (arbitrary included) to unload the ingredients, transport, mix and deposit the concrete in the lock-wall forms, plus plant depreciation. This does not include any labor in the construction plant outside of the power-house.

TABLE VI.—SEGREGATED COST OF STATION OPERATION IN DOLLARS PER MONTH.

Month. 1909.	Operation. 1	Fuel. 2	Repairs. 3	Total. 4
Sept.	$4,276	$1,738	$309	$6,324
Oct.	4,709	3,126	119	7,954
Nov.	4,027	3,710	1,154	8,892
Dec.	4,180	4,061	383	8,625
1910.				
Jan.	4,600	4,959	299	9,868
Feb.	*4,600	8,584	*300	13,293
	†5,417		2,578	
Mar.	*4,600	7,507	*300	12,416
	†4,118		1,252	
Apr.	4,181	7,472	378	12,032

*In Col. 1 operation costs were taken the same as for January, on account of the extraordinary charge of Labor for repairs, which was included in operation. Similarly in Col. 3 for repair Material.
†Total for month, including extraordinary charge.

TABLE VII.—MONTHLY OUTPUT AND COST PER KW.-HR.

Month. 1909.	Total KW.-hr. output. 1	Switchboard cost per KW.-hr. 2 Cts.	Switchboard cost* plus arbitrary. 3 Cts.
Sept.	114,350	5.53	5.53
Oct.	253,780	3.13	3.14
Nov.	349,570	2.54	2.55
Dec.	401,230	2.14	2.58
1910.			
Jan.	514,720	1.91	1.92
Feb.	915,240	1.45	1.46
Mar.	824,426	1.50	1.51
Apr.	865,870	1.38	1.39

*Col. 3 = Col. 2, plus plant arbitrary of $0.0088 per KW.-hr.

TABLE VIII.—OIL CONSUMED AND KW.-HR. OUTPUT

Month. 1909.	Bbls. Oil. 1	Total KW.-hrs. 2	KW.-hrs. per bbl. 3
Oct.	2,481.85	253,780	102.2
Nov.	3,372.8	349,570	103.6
Dec.	3,691.87	401,230	108.6
1910.			
Jan.	4,379.10	514,720	117.5
Feb.	6,937.21	915,240	131.9
Mar.	6,486.09	824,426	127.1
Apr.	6,793.22	865,870	127.4

A CONGRESSIONAL COMMISSION to investigate water-power development and the public land laws is urged by the National Electric Light Association. At a meeting of the Executive Committee of this association, on Jan. 14, the resolutions printed below were adopted. The association now represents about two billion dollars of capital invested in the generation and distribution of electric current and 100,000 employees.

Whereas, The condition of the laws and regulations relating to the public lands of the United States government is so complicated, unsatisfactory and unsettled that the financing and commercial development of new enterprises in connection with public lands is rendered practically impossible; and,

Whereas, The immediate development of the idle water powers of the Nation is of importance to the whole people in that it brings to immediate use an indestructible natural resource that would be otherwise lost or idle and conserves coal, oil, gas and other fuels that are limited in amount and subject to replacement; and,

Whereas, The National Electric Light Association is particularly interested in the situation pertaining to public lands of the United States in connection with the development of water powers; and,

Whereas, Much of the differences of opinion upon the subject of water powers arises from the difficulty of obtaining a clear comprehension of all the facts; now, therefore, be it

Resolved, That this association does respectfully urge that a competent commission, composed of members of the Senate and House of Representatives of the United States, together with persons familiar with the financial and other practical aspects of the situation, be appointed with full authority to collect the evidence, and for that purpose to hold full and complete open hearings in different sections of the country; and be it further

Resolved, That this association does respectfully urge that such commission be appointed at as early a date as possible, to the end that its meetings may be held between the adjournment of the present session of Congress and the reassembling of the new Congress, in the hope that such commission should report upon such reassembling, and Congress be thereby enabled to take prompt action in the enactment of such laws as will permit the development of the natural resources of the country in such a manner as shall render them of the greatest possible use to all of the people.

Designing Concrete Abutments for Steel Highway Bridges.*

By H. E. BILGER.†

To design economically a retaining wall and insure stability is a problem that is not susceptible to accurate mathematical solution. A great many formulas have been advanced that deal with earth pressure under different conditions. But the formulas are necessarily based upon assumptions more or less unknown, and consequently for ordinary cases there is little or nothing to be gained in applying a supposedly rational formula to determine the stability of a retaining wall against overturning.

For plain abutments up to 25 ft. in height the practice of the Illinois Highway Commission is to make the width of the base 33% of the total height, (or 25% where the foundation is to be rock or shale). Our plain concrete abutments rest on a concrete footing 18 ins. thick and projecting 9 ins. horizontally beyond the front and the back of the wall proper. The back of the wall is made vertical, primarily to throw the center of gravity of the wall farther away from the toe, and secondarily for the sake of appearance.

At the end of the wing the width of the footing is 33% of the height of the wall at this place, but with a height less than 13 ft. (when we use the customary 9-in. horizontal offset for the footing), the width of the wall at the top of the footing will be slightly less than 25% of the height. In these cases the width of the wall at the top of the footing is made 25% of the height above the top of the footing, and the horizontal off-set of the footing is adjusted until the width of the footing is 33% of the total height. Wing walls are made 12 ins. wide on top, and the total width of the abutment proper at the top usually varies from 20 to 32 ins., depending upon the size of the shoe that is built for the superstructure. Of this top width, 8 ins. is in all cases used for the parapet wall.

For the reinforced buttress type of abutments it is the practice to make the width of the base 33% of the total height for heights up to 30 ft. Needless to say that the stability moment of the buttress wall is somewhat less than that of the plain or solid type of wall. This is due to the relative amounts of concrete in the two walls, but also because of the center of gravity of the concrete in the buttress wall coming more nearly to the toe of the wall. It is true that the difference in the weight of the two walls is very largely made up by the weight of the backfilling occupying the space between the buttresses; but this compensating factor is not sufficient to make the buttress wall as stable against overturning as the plain wall when the ratio of base to height is the same.

To retain the same width of the footing of the buttress wall, so as to have the design of the two types consistent, it is considered that the anchorage of the wings to the main wall by the horizontal reinforcement is sufficient to make up for whatever difference might exist between the stability of the two types of walls. This anchorage is not considered, however, in cases where the angle between the wings and the center line of the road is more than 45°.

As with plain abutments, the width of the footing at the end of the rings is made 33% of the total height at that point. The footing depth is very frequently 18 ins., but this may vary some 6 ins. either way, depending upon the design required for the particular case. The wall proper is made arbitrarily 12 ins. wide at the top, but at the top of the footing it usually varies from 18 to 24 ins., depending upon the design as required by the conditions. Three buttresses 12 ins. thick are used behind the main wall and occupy the full width of the footings that remains back of the wall. In the wings, the buttresses are placed some 6 or 7 ft. c. to c., depending on the length of the wings. Three buttresses for each wing are commonly used.

The bridge work of the Illinois Highway Commission requires a personal inspection of the bridge site with the local officials, and almost invariably the officials expect that an estimate of the cost will be made at this time. Consequently, the engineer must be prepared to give an estimate that will closely approximate the one that is made from the detailed drawings. This is usually somewhat difficult, unless the time is taken to compute the number of cubic yards in the abutments.

For the purpose of determining off-hand the approximate number of cubic yards in a pair of concrete abutments, the accompanying diagrams have been prepared, and are applicable within the limits shown by the specific cases used. For plain abutments, 27 different designs were taken from the files of the Commission and the number of cubic yards in the two abutments of each design was plotted against H^2 $(R + 2W)$, where (H) is the total height of the wall, (R) the clear roadway of the steel superstructure, and (W) the length of one wing measured on the stream side of the wing. It will be noticed that the number of cubic yards in two abutments varies approximately as the square of the height. The width (R) was taken as the clear roadway for the reason that this is the figure obtained at the preliminary inspection of the bridge site.

It will be noticed that the maximum variation from the line plotted is 8 cu. yds., while the average is about 3½ cu. yds. For a particular bridge site, suppose the distance from the crown of the finished roadway to the bed of stream should be 14 ft., and that the footing should be carried to a depth of 4 ft. below the bed of the stream, making (H) equal to 18 ft. If the wings are each to be 15 ft. long and the abutments are to carry a superstructure having a clear roadway of 16 ft., we have a value of 14,900 to be read off at the bottom of the diagram. It will be seen at once that there are 178 cu. yds. of concrete in the two abutments.

The 27 abutments used in making this figure varied in height from 12 ft. 4 ins. to 24 ft. 3 ins., the average being 17 ft. 4 ins. The wings ranged in length from 5 ft. to 17½ ft., the average being 12 ft. 2 ins. The width of roadway varied from 14 to 18 ft., but was 16 ft. in the large majority of cases. The total width of the wall at the top varied from 20 to 32 ins., the average being 27 ins. In all cases, 8 ins. of this width is used as a parapet wall and comes to the top of the stringers in elevation, the remaining portion of the wall stopping in elevation at the bottom of the shoe.

It might at first be thought that the cubic contents would be more nearly proportional to the height only up to the bridge seat, because the height of the parapet wall is a constant for any given superstructure and is entirely independent of the height of the abutment. After plotting the quantities both ways it was found that the cubic contents varied more nearly proportional to the total height of the wall. The angle at which the wings stood with respect to the main wall ranged in these cases from 30° to 60°. The more nearly the direction of the wing approaches a parallel with the line of the road the higher will be the wing at the end, and consequently the number of cubic yards will be somewhat increased. But as the corner formed by the intersection of the abutment proper and the wing is measured twice, these two factors practically compensate one another.

For reinforced abutments 15 designs were taken from the files of the Commission and the number of cubic yards in the two abutments of each design was plotted against $H \times (R + 2W)$, the notation being the same as before. It is to be noted that in reinforced abutments the cubic contents vary in proportion to the total height, instead of as the square of the total height (as with plain abutments). Take the same abutments: clear roadway, 16 ft.; height, 18 ft., and length of wings, 15 ft. We have 828 as the quantity to be read off from the top of Fig. 1. Getting the intersection with the line for reinforced abutments, we find that the two abutments would contain 120 cu. yds. of concrete. Fig. 1 is thus a ready means of ascertaining very approximately the concrete in two abutments in terms of the height, roadway and length of wings when the design of the abutments is in accordance with the practice as previously described.

Having found the expression that is a measure of the number of cubic yards in a pair of abutments, the next step is to correlate it with a unit price that we may be enabled to arrived at the approximate estimate. For this purpose the diagram shown in Fig. 2 has been prepared.

The actual cost of one cubic yard of concrete complete in place as an integral part of a wall will depend upon a number of individual items. For nearly all ordinary highway bridge abutments only the following items have a very large influence in determining the actual cost per cubic yard: (1) the cost (at the bridge site) of sufficient aggregate to make 1 cu. yd. of concrete; (2) the cost (at the site) of sufficient cement to make this cubic yard of concrete; (3) the cost per cubic yard of concrete to make the necessary excavation to start the concreting of the footings.

There are exceptional cases where the cost of this excavation (which includes also cribbing, sheet piling and pumping) will run as high as $3 or $4 per cu. yd. of concrete. On the other hand in a very few cases this excavation item may fall as low as 75 cts. (or even 50 cts.) per cu. yd. But for probably 85% of all the cases encountered, the excavation item will not vary more than 30% from a fixed quantity.

The item for mixing and placing concrete might vary from $1.25 per cu. yd. for crushed rock concrete, mixed by hand, to possibly as low as 30 or 40 cts. per cu. yd. for gravel concrete mixed by machinery. In spite of this possible wide variation we find that the cost for this item varies but little from a fixed amount. Likewise the item for forms is a more or less fixed quantity for plain abutments and another fixed quantity for the reinforced abutments.

It will be seen that the cost of the cement and the aggregate delivered to the bridge site are the two items that have the most to do with determining the price per cu. yd. of concrete. For plain abutments the sum of these two items will very seldom fall below $2, and will just as seldom exceed $6. Under the most favorable conditions in location near to a railway station, the cost of the cement delivered to the bridge site would hardly fall below $1.50 for plain concrete 1:3:5. Even if satisfactory gravel is available at the bridge site it would cost probably at least 50 cts. per cu. yd. to haul it to the mixing plant. On the other hand the cost of the cement and the aggregate at the bridge site might even exceed $6.

In the light of this, Fig. 2 has been prepared to give the price of two plain abutments under conditions where the cost of the cement and the aggregate at the bridge site might vary from $2 (by $1 increments) to $6, and for reinforced abutments from $2 to $7. The items for forms, mixing and placing concrete, and excavation will be as nearly a constant for the reinforced abutments as they are for the plain abutments.

From the 15 different designs of reinforced abutments which were used in preparing Fig. 1 it was found that the amount of reinforcing steel bars per cu. yd. of concrete averaged 70 lbs., and that the widest variation from this average was small. This item for reinforcing steel, as well as the bending and placing of same, has been duly considered in preparing Fig. 2. Also all other

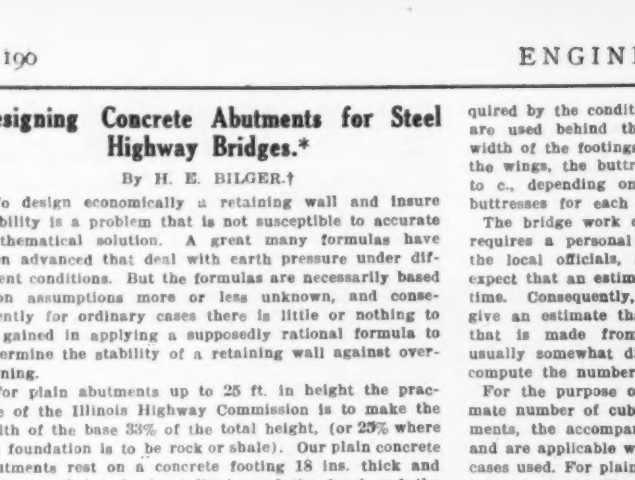


Fig. 1.

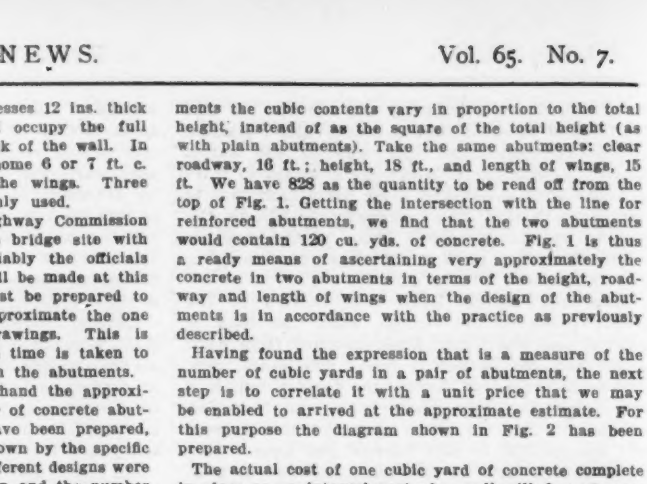


Fig. 2.

DIAGRAMS FOR ESTIMATING THE AMOUNT OF CONCRETE IN HIGHWAY BRIDGE ABUTMENTS, PLAIN AND REINFORCED, AND THE COST.

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, East St. Louis, Ill., Jan. 25, 27.

†Assistant Engineer, Illinois Highway Commission, Springfield, Ill.

items that have a material influence on the cost of concrete in place. For this reinforced work the mixture is 1:2½:5, as against 1:3:5 for the plain concrete.

Assuming the aggregate and the cement at the bridge site for one yard of plain concrete to cost $4, and using the same abutments that were previously considered, we find that 14,900 at the bottom of Fig. 2 intersects the $4 line for plain abutments at a point showing the price of the two abutments to be $1,770. Similarly, 828 from the top of the figure intersects with the $4 line for reinforced abutments at a point showing the price of the two abutments to be $1,620. This is not actual cost of the abutments to the contractor, but rather the price of the abutments; it being the figure at which the township or county can expect to get the work done by contract. By correlating the expression that measures the number of cubic yards in a pair of plain abutments, it would be possible to work out a diagram that would show graphically by the intersection of lines the economical height for any particular set of conditions. But what is wanted more especially is to get the absolute figure on a pair of reinforced abutments, both under the same conditions.

It is not the practice to select the type of abutment merely upon the relative price. A case frequently arises late in the season when the abutments must be built before freezing weather. The reinforced abutments might be the more economical by say $100, but by the selection of this type the work might be delayed two or three weeks in getting the reinforcing steel from the mills. Again, the frequency of freshets might make the contractor's cost of pumping, cribbing, etc., excessive. As it might require two or three times as long to carry the concreting up to the water surface by using the reinforced type as against the plain wall, the latter should be the design adopted, providing the difference between the cost of the two types would not be excessive. It might be mentioned also, that no small part of the concrete work under the supervision of the Illinois Highway Commission is done by local men who have had very little experience with concrete. This point, however, is not considered in selecting the type of abutment, for the reason that the Commission furnishes a competent inspector to superintend the construction of the work. Thus, the complexity of the design is not an embarrassment to the local contractor.

ECONOMY IN USE OF DYNAMITE ON THE PANAMA CANAL.—Less than two-thirds of the quantity of dynamite used in blasting in the Central Division during the months of October, November, and December, 1909, were used during the same months of 1910, although the quantity of rock excavated during these months, in 1910, was almost identical with 1909. A statement showing the amounts by months, and the cubic yards of material excavated per pound of dynamite, follows:

Months.	Dynamite used— 1909. Lbs.	1910. Lbs.	Rock excavated— 1909. Cu. Yds.	1910. Cu. Yds.
October.....	806,700	481,750	1,196,297	1,076,678
November.....	659,600	391,500	968,246	1,053,077
December.....	439,350	427,800	1,005,088	1,008,998
Total.....1,905,650		1,301,050	3,169,631	3,138,753

	1909.	1910.
Cu. yds. of material per lb. of dynamite.	1.66 +	2.41 +
Lbs. of dynamite per cu. yd. of material.	0.60 +	0.41 +

—"Canal Record," Jan. 25.

The Moodie "Selector" for the Separation of Fine Material.

One of the earliest recognized requirements in the manufacture of Portland cement was the necessity for a finely-ground mixture of the raw material as well as of the finished product, and the tendency has constantly been toward finer grinding rather than in the other direction. For the raw material it has been shown that if a sound and constant-volume cement is to be obtained, only a residue of from 5 to 15%, depending on the location of the plant and the nature of the rock, should be left on a 100-mesh screen, and the standard American specifications for a Portland cement call for a finished product of which 90% will pass a 100-mesh screen and 70% a 200-mesh screen. So confident are some of the manufacturers in the desirability of a finely ground cement that a selling point is made of the fact that 98% of the cement will pass a 100-mesh and 90% a 200-mesh screen.

To get this fineness the primary necessity is a mill or grinder that will reduce the material to the necessary pulverized condition but a secondary, and none the less important, necessity is a separator that will remove the larger particles to be reground and leave only the desired fine sizes. In this country the separation has generally been made with some sort of sieve or screen, a number of which have been devised to care for the peculiarly refined screening called for. In Europe, however, and particularly in Germany, extensive use has been made of air or centrifugal separators, machines in which the fine material is separated either by the action of centrifugal force or by a current of air being blown through the ground mixture. Such separators are being installed in American mills in increasing numbers.

One of the earliest of patents upon such devices was obtained by Robert Moodie and for many years his so-called "separator" with various improvements, was a standard. Recently he has improved the separator by adding several important details and has called the new machine the "selector." At the last meeting of the Association of American Portland Cement Manufacturers, Mr. Oscar Pfeiffer, of the firm of Gebr. Pfeiffer, Kaiserlautern, Germany, read a paper describing this "selector," which is manufactured by his firm. From that paper and from other sources we have prepared the following description.

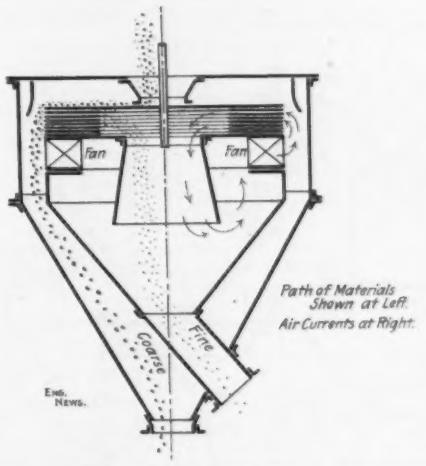


Fig. 1. Diagram Showing Action of the Moodie "Selector."

In the Moodie separator the material to be sifted drops through a hopper onto a rapidly rotating plate, enclosed in a metal casing. This plate serves to spread the material and throws it off in a thin sheet at the circumference, where it encounters a current of air blown up from a fan below. This current of air carries with it the finer particles, which are deposited against the inner face of the casing and are carried off through a chute to the transporting mechanism, while the heavier particles drop through the air current to another chute, to be carried back to the grinding mill for further reduction. The variation in fineness can be regulated by intensifying or reducing the current of air. This machine has had many improvements in the matter of fan placing, extra rotating disks, etc., but its principle is as described.

This separator was efficient up to a certain point, but the increasing demand for a finer gradation of particles led to the invention of the "selector." In general design the "selector" is the same as the separator, depending for its action upon a current of air and an initial centrifugal deposition, but there has been added a series of closely spaced thin circular revolving disks through which the material must pass after first meeting the air current and which by frictional retardation and centrifugal action still further continue the classification.

A diagram of the "selector" is shown in Fig. 1. This view shows only the general outline of the machine and serves only to illustrate its method of operation; the details of construction and relative position of parts are not necessarily the same as in the actual "selector." It consists of fixed outer and inner casings, with a central shaft carrying horizontal circular blades and a horizontally placed fan, all geared to the drive, as shown in Fig. 2. The material to be separated drops from the grinding mill into the upper hopper and from there to the upper of the circular plates, known as the "spreader plate." From this plate it is driven outward by centrifugal force to the space between the outer and inner casing where it would naturally tend to fall down to the chute marked "coarse" did it not encounter the blast of air coming up this space from the fan. This air blows the finer particles into the narrow openings between the nest of revolving disks, while the larger particles drop down the chute to the "coarse" opening. Up to this point the process is the same as in the "separator," but the disks are the novelties that give the device its name. The fairly fine material drawn through the disks by the current of air is now separated further by the rotation of the disks and the heavier material rejected, to fall down the "coarse" chute, while the very finest material, which is not thrown out and which passes the disks, drops down the inner casing to the chute marked "fine." The degree of separation is regulated by the force of the air current, the spacing between the disks and the relative roughness of the faces of the disks.

This machine, patented in this country by the Gebr. Pfeiffer, comes in sizes delivering from 0.3 to 5 tons per hour. The smallest of these requires about 5 ft. square of floor area and stands 8 ft. high, and the largest, 10 ft. square of floor and is 14 ft. high. The product, it is claimed, will all pass a 100-mesh sieve and will pass 90% through a 200-mesh sieve. Using the "selector" a number of German mills now claim that 90% of their raw material, 95% of the finished cement and 95% of the coal will pass through a 200-mesh sieve.

Mr. Pfeiffer stated that some German mills are now turning out a "selector"-sieved cement known there as "edel-cement," which is remarkably fine, and which shows a strength far above the ordinary commercial cement. Whereas the standard German specifications call for a cement

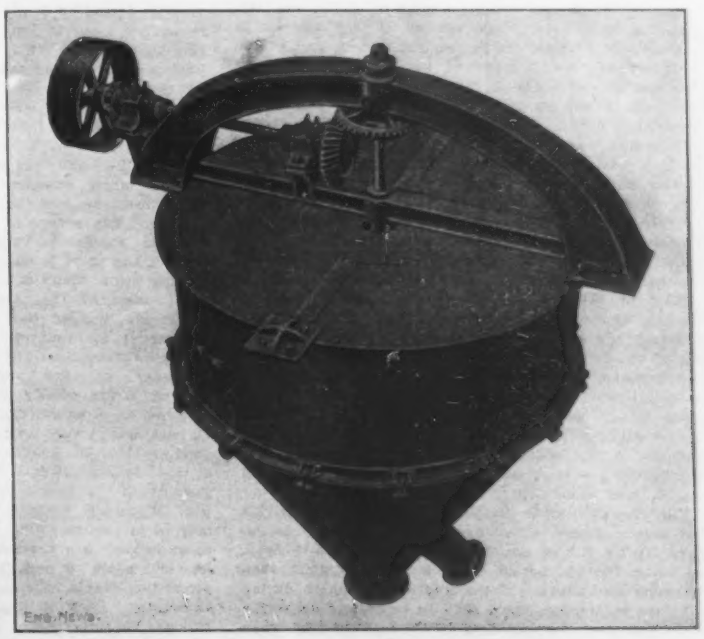


FIG. 2. EXTERIOR VIEW OF THE MOODIE "SELECTOR" FOR THE SEPARATION OF FINE MATERIAL.

95% of which will pass a 76-mesh screen and which will have a crushing value, in a 1:3 mortar at the end of 28 days, of 3,570 lbs. per sq. in., this "edel-cement" passes 100% through a 100-mesh, 90% through a 200-mesh and 75% through a 300-mesh screen and has a crushing strength of 8,515 lbs. per sq. in. in a 1:3 mortar at the end of 28 days.

A Pumping-Irrigation Project With a Central Power Plant.*

By ROBERT P. WOODS,† M. Am. Soc. C. E.

It is customary to consider land that receives less than 20 ins. average annual rainfall as arid. Included as such is about two-fifths of the area of the United States, embracing the land extending approximately from the middle of the continent west to the Pacific Ocean. This is the land that requires irrigation, and for some of it certain provisions have already been made, but for only a small part. That more has not been done, is not because irrigation is new, but because the initiative and capital were lacking.

Nearly all of the irrigation work accomplished to date has been by gravity. Probably not 40% has been by pumping. But rapid strides have been made in pumping methods in the last two years, and the future is promising. Probably not more than one-tenth of the arid land can be reclaimed by gravity irrigation. Many of the rivers are too low and impounding of some is not practicable. There are many situations demanding the pumping of water, among which are those requiring water lifted from rivers, lakes, wells, from underflow in valleys, from irrigated land that has poor drainage and which otherwise would become waterlogged or soured, and for raising water from established canals to higher ground for further distribution. Properly designed pumping projects on relatively large scales are less expensive to construct, and no more expensive to operate and maintain than gravity works.

One of the largest irrigation projects in this country, pumping from underground sources, is that adjacent to the town of Portales, in the central eastern part of the Territory of New Mexico and but recently completed. The distinctive features of this installation are (1) pumping from a sub-surface water strata or underflow by electrically-driven direct-connected, horizontal, centrifugal pumps, and (2) the distribution of current to the various individual pumping plants from a central power station where it is generated by three-phase, alternating-current generators direct connected to gas engines.

ORGANIZATION.—The project is controlled by the Portales Irrigation Co., a community corporation of energetic resident farmers, who arranged for the drilling of their individual wells. It was developed and exploited by the Western Construction Co., of Wichita, Kansas, and constructed by them under the immediate direction and supervision of the writer. The stockholders of the irrigation company are individually owners of the numerous parcels of land embraced in the 10,000 acres irrigated in this undertaking and, subject to an issue of first mortgage 6% gold bonds, are the owners of the entire works. A map of the project is shown in Fig. 1. Actual construction began in February, 1910, and partial operation was started in August. The work was finished about Jan. 1, 1911.

PLANT.—The power plant has a capacity (by driving the several pumps distributed over the project) to deliver 100 cu. ft. per sec. of water against a 45-ft. head, including friction, or an equivalent thereto and, when operating continuously at the rate of 100 sec.-ft. during 151 days of 24 hours each, shall be capable of delivering three acre feet of water upon 10,000 acres of land when pumped against the total head of 45 ft., or its equivalent if against a different total head.

Each pumping station is provided with a pump and motor of sufficient capacity to provide 2 sec.-ft. of water for each 100 acres.

A water duty of three acre feet is undoubtedly more than will be needed; two is ample.

TOPOGRAPHY.—The Rocky Mountain ranges extend into the north, west and southwestern portions of New Mexico. The eastern, southern and part of middle western portions are on high plateaus or river valleys. The altitude varies from 3,000 to 8,000 ft. above sea-level; that at Portales is 4,050 ft. The soil varies from a reddish, sandy loam to an occasional adobe. It is alluvial in character, derived principally from volcanic rocks, and is fertile, rich in potash and phosphoric acid, and fairly well supplied with humus that is rich in nitrogen. The nitrogen contents can be easily maintained and increased by the use of leguminous crops, such as peas and alfalfa, in a crop rotation. A gypsum rock formation occasionally underlies the loam and clay strata.

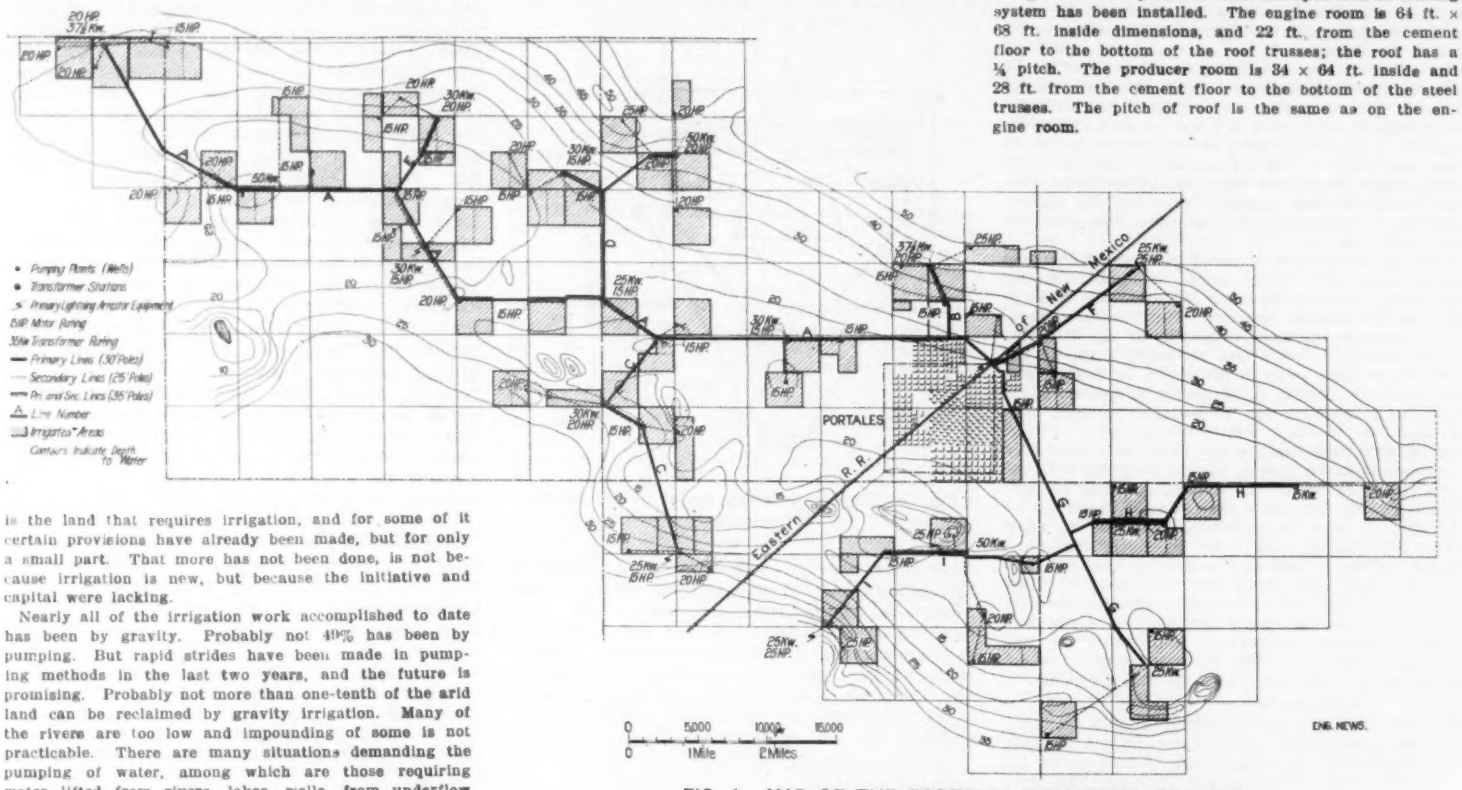


FIG. 1. MAP OF THE PORTALES IRRIGATION PROJECT.

RAINFALL.—The average annual rainfall for New Mexico is from 10 to 20 ins., with the higher averages in the eastern portion. The figure for Portales and vicinity during 1905 and 1906 was 21.30 and 21.78 ins., respectively, but in 1907-'08-'09 it was scarcely 10 ins.; 1910 showed 14.75 ins. Owing to the wide range in temperature between day and night, the mean yearly is from 44° to 62° F.

WATER SUPPLY.—Because of the broken stratification in the natural formation of New Mexico, a great many of the small, and some of the larger streams entirely disappear into the underflow. The source of the Portales supply is underground, and there is no river flowing within many miles of the project. The theory has been advanced that the contour of the country, the geological formations and the character of the water-bearing strata clearly indicate that the source is that of an old-time river formerly connected to the headwaters of the Brazos River. This theory in all its fullness is properly doubted. It may be in part as stated, because located in a broad valley, and again in part from percolation over a wide range of country. Lack of investigations requiring time and expense prevents clear analysis at this time.

There has been no official test of the individual plants as yet, but while developing the wells it was noted that for about six hours one day there were 40 plants in operation and, although the power station equipment was operating below full speed and the wells were yielding much sand, each well was delivering from 400 to 1,200 gals. per min.; a fair average would be 650 gals. per min., or a total of 26,000, a highly satisfactory showing.

CENTRAL STATION.—The power station (Figs. 2 and 3) is located about one mile north from the center of Portales, and adjacent to the Eastern R. R. of New Mexico, a branch line of the Santa Fe system. The building is as plain as it was possible to construct it; the main idea was to secure a good substantial structure. The foundations are of concrete, all the walls of brick, the roof trusses of steel and the roof covering heavy galvanized iron. The plant is for irrigation of farm lands only, and not intended to operate in the winter, hence the gables in the producer room are open and no heating system has been installed. The engine room is 64 ft. × 68 ft. inside dimensions, and 22 ft. from the cement floor to the bottom of the roof trusses; the roof has a ¼ pitch. The producer room is 34 × 64 ft. inside and 28 ft. from the cement floor to the bottom of the steel trusses. The pitch of roof is the same as on the engine room.

FIG. 2. CENTRAL POWER STATION OF THE PORTALES IRRIGATION PROJECT.

The water for plant operation is derived from a special well located in a brick pump-house adjoining the plant (Fig. 5). The well was drilled about 110 ft. At 21 ft. below the surface of the ground, the first strata of water was encountered and the pumping equipment consisting of two No. 4 horizontal centrifugal pumps, direct-connected to two 20-HP. motors, were placed 1 ft. above the water on concrete foundations. The pit (Fig. 4) was made 11 ft. in diameter and cased with concrete. One pump is sufficient, the other being a spare unit. The water is pumped into a steel tank holding 15,000 gals., the bottom of the tank being elevated 50 ft. above the ground; this height was necessary to obtain proper pressure for engines. The main supply pipe is 8 ins. with a 4-in. branch to the producers, and a 6-in. branch to the engines.

Adjoining the producer room is a coal bin 60 ft. long × 30 ft. wide with average height of 8 ft. The coal is taken from the bin in a bottom-dump hopper on a push car operated over a 24-in. gage industrial track. The hopper holds about 730 lbs. of bituminous coal. Im-

*From a paper read before Indiana Engineering Society, Indianapolis, Jan. 13, 1911.

†801 Traction Bldg., Indianapolis, Ind.

mediately inside of the building the hopper is raised about 18 ft. by an electric hoist and conveyed to the coal gallery by a trolley wheel operating along an 8-in. beam suspended over the gallery. This coal gallery or charging platform is along one side of, and level with, the tops of the producers.

ENGINES.—There are two 27 × 36-in. Westinghouse, horizontal, tandem, double-acting, single-crank, direct-connected, 750-HP. gas engines; the speed at normal load is 152 r. p. m. Rating as at the altitude of 4,000 ft. above sea level, the engines can be overloaded 10% for three hours. They are governed by automatically cluding the alternator it is 161 tons. Each fly-wheel weighs about 41 tons. At least four pieces of each unit had to be handled in erection weighing over 20 tons. No crane has as yet been installed.

The engines are started by air pressure, the starting equipment consisting of an air compressor belt-connected to a 20-HP. gasoline engine. There are five air-storage tanks, each about 2 ft. 9 ins. in diameter by 5 ft. in height. The initial ignition service is from a storage battery which is charged by a ¾-KW. generator. This, in turn is operated by the gasoline engine connected to the compressor outfit. After starting, the ignition is transformers have been used. The switchboard and lightning-arrester equipment is of standard design and consists primarily of a four-panel switchboard, electrolytic lightning arresters, with the necessary ammeters, wattmeters, switches, circuit breakers, choke coils, etc.

PRODUCERS.—The equipment consists of three 500-HP., double fire-zone, center-offtake, suction-type, bituminous-gas producers; three No. 7 Root-type exhausters and one No. 4 size as an auxiliary; three dry scrubbers, each about 6 ft. in diameter by 8 ft. in height; three static washers; three 25-HP. motors for operating the three large exhausters; one 12-HP. gasoline engine for

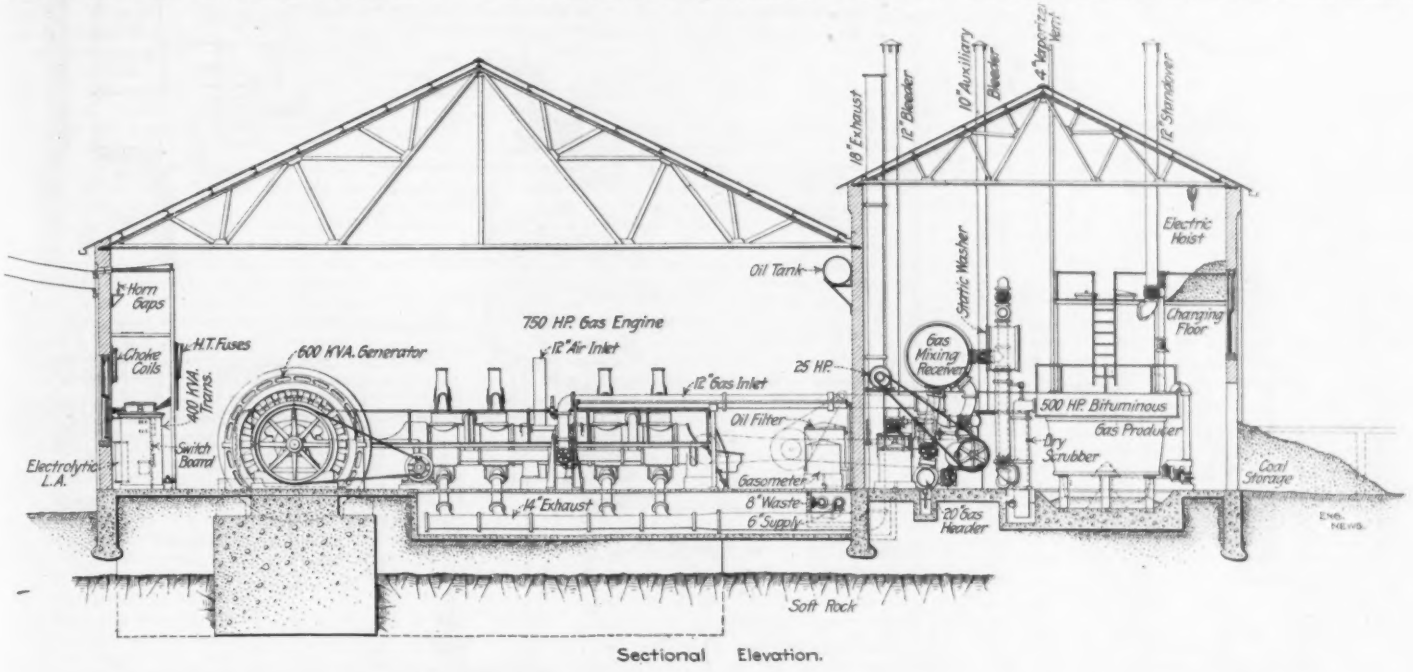


FIG. 3. PLAN AND SECTIONAL ELEVATION OF GAS-POWER STATION, PORTALES IRRIGATION PROJECT.

controlling the explosive mixture to suit the load on them; the inlet gear is especially adapted for the bituminous gas. The gas has a minimum heat value of not less than 110 B. T. U. per cu. ft., effective, at 62° F. and 30 ins. of mercury. It is supplied to the engine at not less than 2 ins. pressure by water column and at a temperature of about 80° F. The pressure of gas going to the engines is controlled by two gas regulators, acting on two butterfly valves.

The engine foundations are of massive concrete extending to rock formation, 14 ft. below the base of the frame. The weight of one engine alone is 146 tons, in-

furnished from a small motor-generator set located at the switchboard.

A continuous-pressure oiling system is installed. This includes a storage tank placed on a bracket on the division wall about 20 ft. above the floor, and two filter tanks located on the floor, below the filter.

GENERATORS.—There are two 600-KVA., three-phase, 60-cycle, 600-volt, 152-r. p. m. alternating-current, engine-type generators. There are also two 25-KW., 125-volt, 1,100-r.p.m. belt-type exciters, belted to a pulley on the shaft extension of each generator unit. Three 400-KVA., 600—11,000-volt, oil-insulated self-cooled

operating the auxiliary exhauster; two gasometers; a gas mixing drum or header, 6 ft. in diameter and 52 ft. in length; a 20-in. gas-supply header, 52 ft. long; together with necessary water-supply and discharge pipes, gas and air piping, valves and accessories.

Each producer consists primarily of an upper and a lower cylindrical steel shell of about ¼-in. plate, riveted and calked and lined with 9 ins. of first quality fire brick laid in fire clay and rubbed to close joints. The upper shell is a little narrower than the lower. Midway between the two is a hollow annular steel forging called the vaporizer which is kept filled with water to within

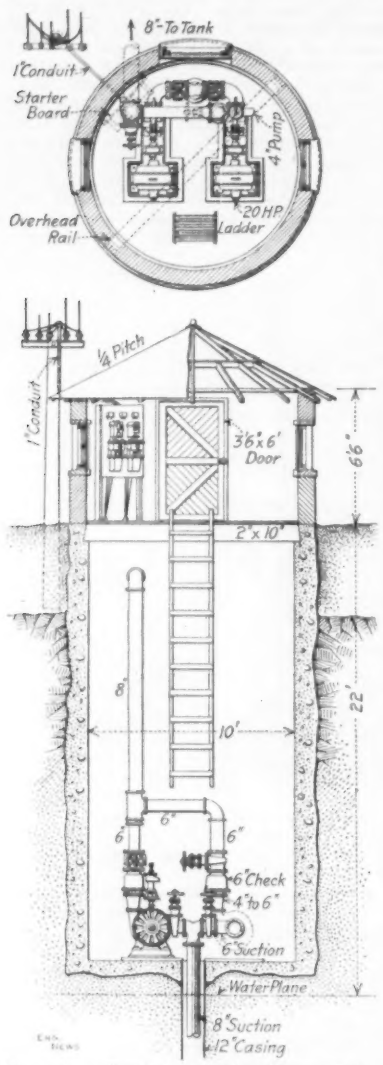


Fig. 4. Central - Station Pump Pit; Portales Project.

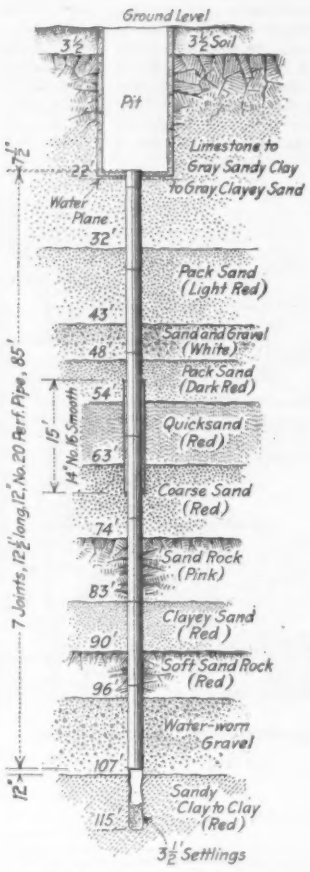


Fig. 5. Strata of Power-House Well.

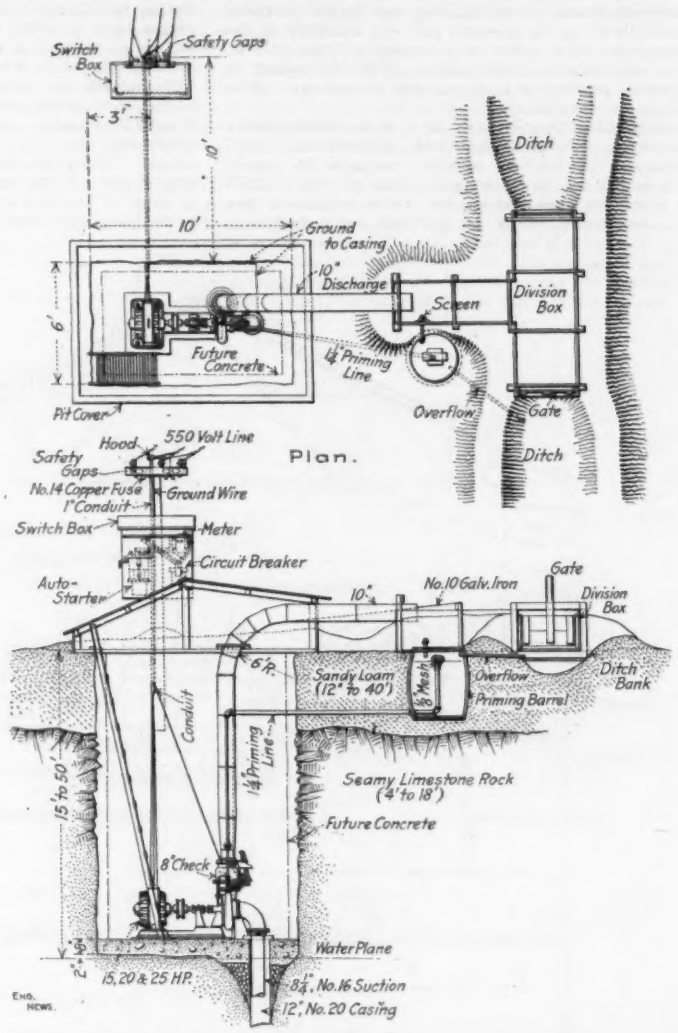


FIG. 6. TYPICAL ARRANGEMENT OF INDIVIDUAL PUMPING PLANT; PORTALES PROJECT.

several inches of its top, permitting air to mix with the steam from the water. The gas offtake also is led through this forging. The lower shell rests on a cast-iron base, the lower part of which extends into the water pan of the foundations, forming a water seal. Suitable poke holes are provided which afford access to all parts of the fuel bed. The top, which is water cooled, has four coal-charging openings each about 18 ins. in diameter. Air pipes connect the atmosphere with the vaporizer and top of the upper zone and with the tuyere or air inlet in the center and lower part of the bottom zone. The maximum width of the producer is 13 ft. 6 ins., and the height from floor to top is 16 ft. The weight of a producer installed, including brick work, is about 60 tons. [The design and operation of this type of producer was described in Engineering News, July 1, 1909, p. 13.—Ed.]

GENERAL EFFICIENCY.—A bituminous coking New Mexico coal containing about 12,500 B. T. U. per lb. is used at the plant. The cost in the plant bin is $5.20 per ton, but this may be cheapened later. The performance of the various pieces of apparatus described is such that the cost of the items of fuel, labor, oil and waste for the power plant is less than 1 ct. per KW.-hr. as measured at the bus bars when the engines are operated at full rated capacity, and the cost of the same items is less than 1½ cts. per KW.-hr., measured by the meters at the various individual pumping plants.

TRANSMISSION SYSTEM.—The total length of the transmission lines is 73.75 miles of which the primary line (11,000 volts) has 38.40 miles and the secondary line (350-volt alternating-current) has 35.35 miles. They are designated by letters from A to I inclusive, as shown on the accompanying map. The longest line, leading direct from power station, is slightly over 15 miles. All of the lines are of bare copper wire varying in size from No. 8 to No. 3. The total lineal miles of wire used was 225 and the total weight about 100,000 lbs.

Excluding the step-up transformer equipment at the power plant there are 17 transformer stations in the project. The housing consists of a small frame structure partly closed. Each station has a bank of three 11,000—375-volt outdoor-type transformers varying from 25 to 50 KVA. capacity.

In six of the 17 transformer stations, primary-potential lightning arresters were placed. These were proportioned according to distance of line as nearly as possible.

Wherever primary and secondary lines are on the same poles, a 35-ft. length was used. For the primary lines alone, the poles were 30 ft., and for secondary lines alone, 25 ft. The poles are cypress having 7-in. tops. The cross-arms are a standard 6-ft. form of Washington fir. The poles were painted with 2 coats of carbolineum for a distance of 2 ft. above and 2 ft. below the ground line.

INDIVIDUAL PUMPING PLANTS.—Excluding the pumping plant at the power station, there are 69 individual pumping plants. They are so much alike in their salient features that one may be considered typical of all. (Fig. 6.)

The distance from the surface of the ground, at the various wells or plants, to the surface water or water plane varied from 15 ft. to 50 ft., as shown in Fig. 1. Pits were dug by the farmers around the wells, 6 x 10

FIG. 7. HOUSING OF TYPICAL PUMPING PLANT.

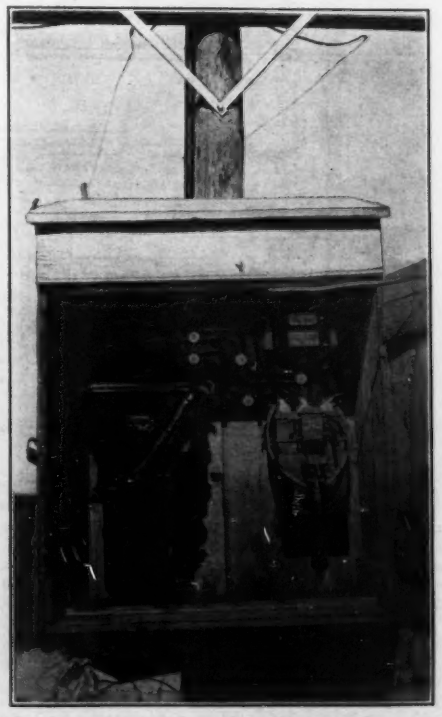


Fig. 8. Motor Control Box.

ft. down to the water and the pump and motor were placed in these pits, within 6 to 12 ins. of the water plane and resting on a concrete foundation. The walls of the pits were not cased. This has been left to future prosperity, or posterity. In most instances the soil seemed firm enough to stand unprotected for a couple of seasons but where questionable the sides were shored with timber.

The equipment at each plant includes a special 6-in. horizontal centrifugal pump with an extended base and flexible coupling to receive a motor. These pumps have a capacity of 900 gals. of water per min. each, when running at a speed of 1,135 r. p. m. against the total head assumed. The suction is 6 ins., discharge 8 ins. and the diameter of shaft 1½ ins. An open impeller is used. Each pump is equipped with a cistern pump, nipple and valve connected in top of volute for priming. There is also an 8-in. vertical check valve with flange connections and a 6 to 8-in. increaser elbow for the suction.

Induction motors are used at the various plants and they vary in size from 15 to 25 HP., and are a standard three-phase, 60-cycle, 550-volt, 1,135-r. p. m. type. The current is carried down to the motor on three rubber-covered, copper wires placed in a small iron pipe conduit, joining the secondary line on a small pole a few feet from the pit as shown in Figs. 6 and 7.

A 30-ft. length of standard 8-in. steel casing is screwed to the pump-suction elbow and suspended in the well, acting as a suction or tail pipe to exclude air and preserve a vacuum when starting the pump. The discharge pipe is of 10-in. heavy galvanized iron, increasing from 8 ins. at the check valve to 10 ins. in a distance of about 6 ft. A long radius elbow is placed near the top of the pit.

The pit is covered with wood structure, very simple and inexpensive. (Fig. 7.)

The equipment for controlling the motors is located in a small wooden box fastened to a small pole near each plant. (See Fig. 8.) It consists of an automatic starter, a circuit breaker, and a recording wattmeter. Above the box on the cross arm are three safety spark gaps for lightning protection.

The discharge weirs or boxes were to be built by the individual land owners and vary from concrete and wood to none at all.

The pumping equipment at the power plant, shown in Fig. 4, differs from the individual farm plants in that it has two No. 4 pumps, and two 25-HP. motors; wrought iron discharge pipe, a concrete-lined pit and a brick pump-house, with the starting equipment in the house. This pit may be considered as the type which the others will approach as the construction is made more permanent.

WELLS.—The general character of the formation of the various strata at most of the wells is fairly represented by that at the power plant (Fig. 5). Beginning at the surface of the ground this well shows 3½ ft. of soil; 28½ ft. of miscellaneous limestone and gray sandy clay and gray clayey sand, with the water table 22 ft. below the level of the ground; 11 ft. of pack sand, light red in color; 5 ft. of sand and gravel, white; 6 ft. pack sand, dark red; 9 ft. quick sand, red; 11 ft. coarse sand, red; 9 ft. sand rock, pink; 7 ft. clayey sand, red; 6 ft. soft sand rock, red; 11 ft. water-worn gravel; 8 ft. sandy clay to clay, red. The total depth from surface to bottom of well is 115 ft. Two steam and one gas-engine cable-rig machines were used in drilling the various wells.

The depth of drilling averaged about 90 ft. below the bottom of the pit or water plane; the depth depending on the apparent sufficiency of the water supply as judged by the character of strata encountered; the desired amount being 2 cu. ft. per sec. or 900 gals. per min. The water plane varied in depth below the surface of the ground from 15 to 50 ft.

The wells were drilled so as to insert a 14-in., 16-gage, galvanized-iron pipe casing. Whenever a quicksand stratum was encountered if the thickness exceeded 1 ft., it was cased off with either 14 or 16-gage galvanized iron to 3 ft. below the quicksand; all other casing was 20-gage galvanized-iron pipe, and at all water-bearing strata, excepting quicksand, it was perforated with slots 1 in. in length, ⅛-in. in width, spaced on about ⅜-in. centers transversely and on 1¾-in. centers longitudinally. The discharge pipe at all plants, excepting the one at the power plant, was 10-in. galvanized iron; at the latter it was standard wrought-iron pipe.

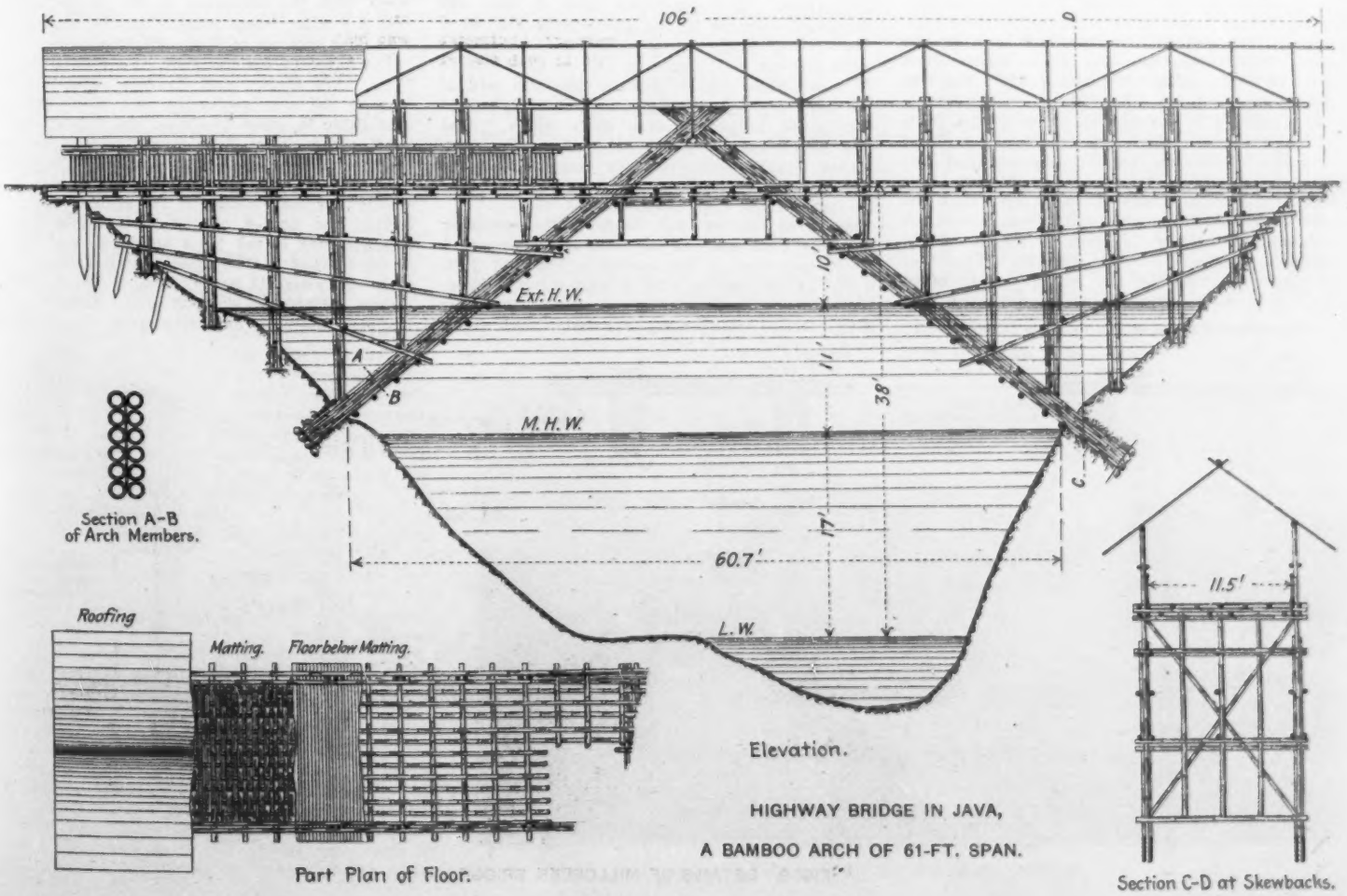
A Bamboo Arch Bridge in Java, Dutch East Indies.

By W. G. BLIGH, M. Inst. C. E.

As a counterfoil to the numerous excellent reinforced-concrete arch bridges recently illustrated in Engineering News, the accompanying drawing of a similar engineering structure but formed of an entirely different material will be interesting, particularly to engineers in the Philippines. It is an example of one of the innumerable uses to which that valuable giant grass, the bamboo, can be put. The bamboo, as most people know, is of two distinct varieties: one is the solid bamboo of which the familiar Japanese furniture is made; the other, utilized for curtain rods and poles, is the hollow bamboo, which is of much larger dimensions. Both are of the same species, but the former is the male and the latter the female variety. In tropical and sub-tropical countries the hills are often covered with a forest of immense clumps of bamboo, some 20 ft. in diameter, with a height of 50 to 60 ft.

This bamboo jungle is a most formidable obstacle to surveying operations or to road alinement, as the writer has himself experienced. But it is very useful for building purposes. A dwelling-house can be knocked up on the spot with roof and wall matting woven in a few hours, exclusively out of the green bamboo. The hollow bamboo is very light and immensely strong and is universally used for scaffolding, ladders, etc., in the East. Bamboo parts are connected together by lashings formed of the skin of the bamboo itself, as may be noticed in Japanese furniture, so that no nails are required, although occasionally wooden or bamboo spikes are driven through to assist the fastenings.

The illustration given herewith is of a road bridge spanning a stream in Java composed entirely of this material, which was constructed by the Government Public Works Department. The length of the bridge is 106 ft., and the span between abutments or feet of the main posts is 60.7 ft.; one abutment is slightly higher than the other. The whole structure is roofed over, apparently with planks, to protect it from the sun and rain, and thus protected the structure will probably last for 10 or 15 years, by which time local increase in population and cultivation will admit of the substitution of a permanent bridge. The bridge is evidently intended for cart traffic, and a layer of gravel and earth will probably be laid over the matting which forms the bridge deck. The drawing is obtained from the Journal of the Royal Institution of Engineers of Holland.



HIGHWAY BRIDGE IN JAVA,
A BAMBOO ARCH OF 61-FT. SPAN.

A Through Reinforced-Concrete Arch Bridge.

By E. A. GAST.*

This bridge is located about eight miles north of the business center of Cincinnati, O. It carries Benson St., the main thoroughfare between the villages of Reading and Lockland, over the East Fork of Millcreek. The old bridge at the site was a through Howe truss bridge with Phoenix columns and cast-iron intersections. The span was 73 ft., with a clearance of about 20 ft. from creek bed to roadway surface. A peculiar feature of this old design was the fact that the lighter diagonal tension members were made up of pipe sections to give them a heavier appearance. Although this bridge had been in use since 1860 it was found to be in an excellent state of preservation when torn down. The new bridge was built by the authority of the Hamilton County Commissioners, whose policy it is to rebuild the bridges in the county of reinforced concrete as fast as the old ones of wood and iron become unfit for use. In looking over the site of this bridge it was found that the present waterway opening must be preserved, on account of the large amount of water coming through the creek at flood periods. This fact prevented the use of any of the usual types of arch bridges. The bridge decided upon was to have a span of 73 ft. and a roadway of 31 ft. with two sidewalks of 9½ ft. each, making a total width of 50 ft. Two estimates were made for this bridge, one of steel girder construction, estimate being $11,000, the other of reinforced-concrete construction, the estimated cost of which was $8,600.

The County Commissioners decided upon the latter and ordered plans prepared for same. The design chosen, using hingeless arch ribs above the floor line, is an unusual one and possibly the first of its kind in this country, although several like it have been built in Europe.

*Deputy County Surveyor, Hamilton Co., Cincinnati, O.

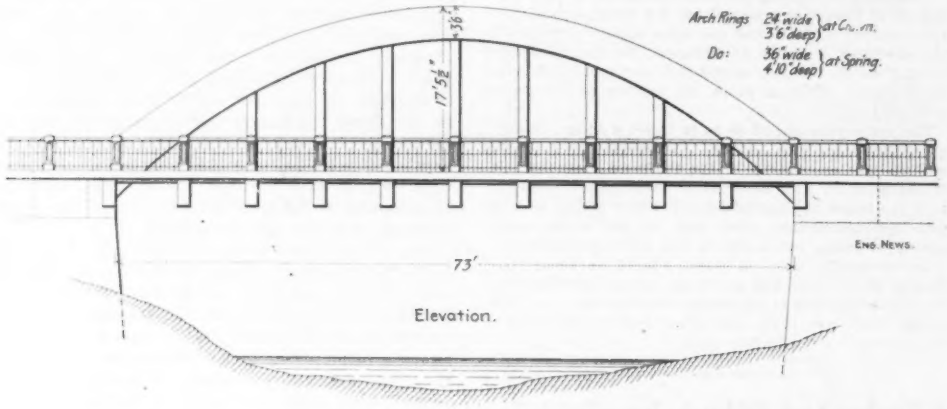
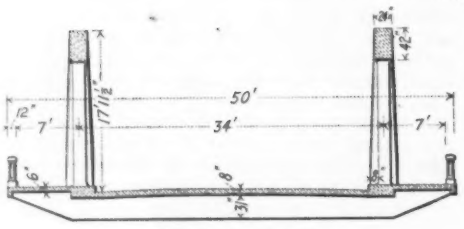


FIG. 1 REINFORCED-CONCRETE THROUGH ARCH BRIDGE OVER MILLCREEK AT BENSON ST., NEAR CINCINNATI, O.



Design.

The bridge consists of two hingeless reinforced-concrete arch ribs, built entirely above the roadway, the thrust being cared for by tension steel in the plane of the floor tied thoroughly around the steel in the ribs. The roadway is suspended from the ribs by nine hangers of reinforced-concrete, the steel rods, hooked around rib reinforcement above and floor rods below, taking all the stress. This particular type of arch was developed because in the preliminary studies it was found that the old masonry abutments were in such good condition and of such size as to make them amply able to take the load of the new bridge, provided the weight could be distributed uniformly over their width. The tied arch causes only vertical load on the abutments and to distribute this vertical load the heavy transverse beams, shown on Figs. 2, below the arch ends were designed.

The arch ribs are 3-ft. wide at the springing line and 3 ft. wide at the crown. They are 4 ft. 10 ins. deep at the springing line and 3 ft. 6 ins. at the crown, with a uniformly decreasing section from the spring to crown. The floor is of slab and transverse girder design with cantilever sidewalks, each girder being attached to two transversely opposite hangers. These cantilevers give a total width of 50 ft. to the bridge, although the abutments are only 36 ft. wide.

No provision was made for a movement at the abutments due to temperature changes, and the transverse beams at the abutment were laid directly upon the old masonry. The arch ribs, however, were designed to care for all temperature stresses. Although the bridge has now experienced some of the hottest as well as coldest weather of this climate, not a single crack has developed.

The wind bracing, and also the long column effect in the arches, is taken care of by the hangers, the steel in these hangers being placed near the short sides to reinforce them for this purpose. It was found that there is a very large horizontal shear in the arch rib at the haunches equal to the total horizontal thrust. This shear lies in a horizontal plane just above the tension reinforcement, and must be thoroughly taken care of. This shear does not appear in arches where the thrust is taken by solid masonry foundations.

The bridge is designed to carry two 40-ton street cars. The maximum stresses allowed were 16,000 lbs. per sq. in. for steel, and 600 lbs. per sq. in. for concrete in compression.

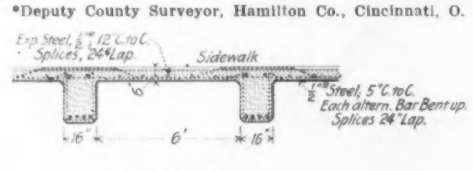
Erection.

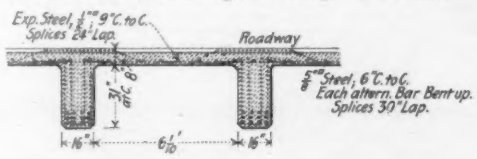
A novel plan was decided upon in erection. The floor and haunches of the arches were built on a heavy falsework, then the hangers were erected and cast in concrete, and finally the arches were built in place. On account of this method of construction it was necessary to build very heavy falsework. This falsework was made up of six timber bents placed laterally, one at each abutment and one under every other cross girder. The caps of these bents were built to such an elevation that they produced the proper camber in the bridge. On these bents eleven lines of 12 × 12-in. longitudinal joists were placed, equally spaced. These joists rested upon 12 × 12-in. corbels, which in turn rested upon wooden wedges laid on the bents. These wedges were used in finally striking the arch. The formwork with the exception of the girder bottoms and 2 × 6-in. joists supporting the slab forms, was built entirely of ⅞-in. sheeting.

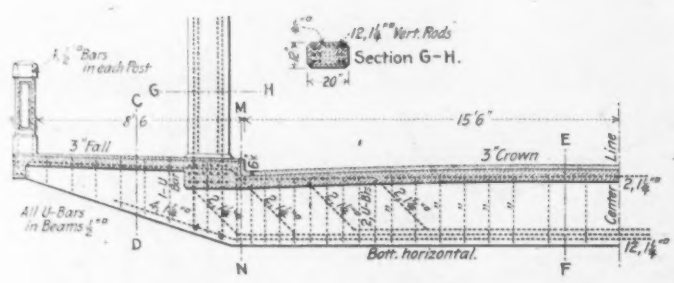
The concrete for the floor was poured in sections, each girder, and its slab extending half way to the next girder on each side, was cast monolithic in order to obtain the T-beam effect.

After the entire floor was finished the steel for the hangers was erected, forms built around it and the concrete poured. This gave a rigid support for the building of the arch forms. Concreting the arches offered little difficulty; the concrete was raised by a small car run on an inclined track. The time required to fill one arch was about 12 hours, using a small mixer.

This method of erection was thought to be the best, after an extensive study into methods







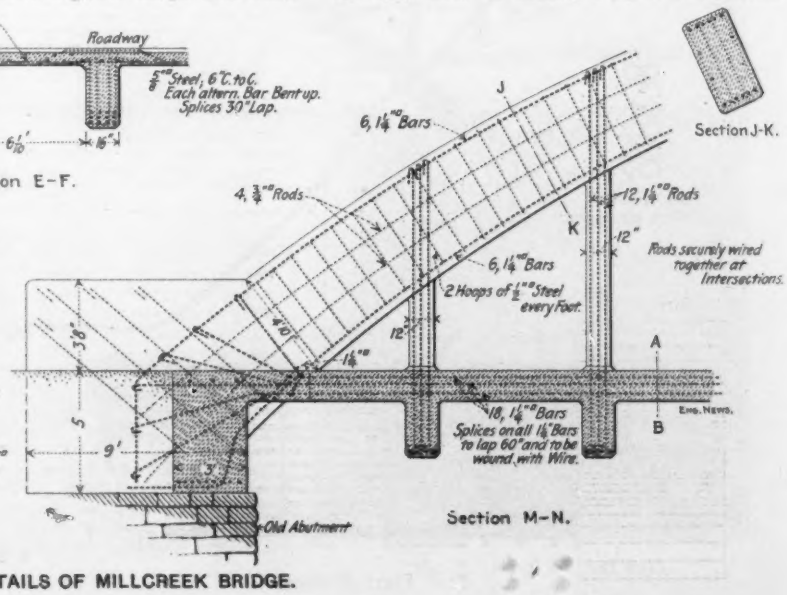


FIG. 2. DETAILS OF MILLCREEK BRIDGE.

whereby the arches could be erected first. Many difficulties would have been encountered had the arch ribs been erected in advance. Heavy falsework would have had to have been erected from the creek bottom to support them; which falsework would have been in the way of the floor erection, since it could not have been removed until the tension rods were in place (and thoroughly bound and spliced by the concrete in the floor) to take the thrust of the arch. There would also have been considerable difficulty in getting a monolithic piece of work. The concreting of the hangers would have offered more difficulties since it would have been almost impossible to obtain a water-tight job as the concreting approached the top where the hangers join the arch ring.

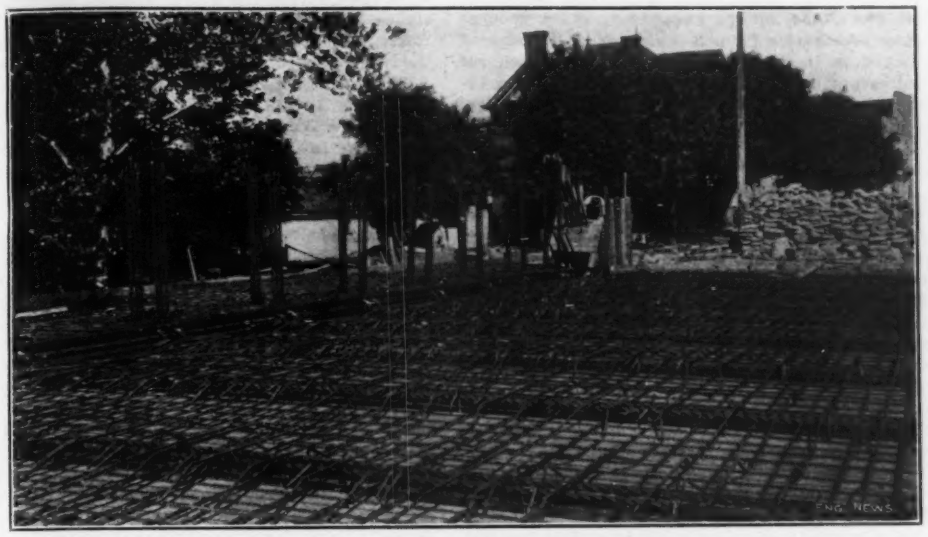


FIG. 3. VIEW OF FLOOR OF BRIDGE DURING CONSTRUCTION SHOWING HEAVY REINFORCEMENT.

The advantages to be derived by the method used were as follows: Travel was maintained for the longest possible time as the old bridge was left in place until the heavy falsework was all in and ready for the floor forms. The old bridge was then taken down, using this falsework as a working platform and support. The formwork for the floor was then laid and from this time on the contractor had a solid floor to work upon with much less danger of accidents. After the concrete floor was laid the hanger forms were erected and filled with concrete, and in a day or two this concrete had set to such an extent that the hangers were immovable and the arches could then be erected with a minimum amount of side bracing, since there was no possible chance for these forms to shift out of alinement.

The reinforcing was entirely of cold twisted steel, the bending all being done on the site. Considerable trouble was experienced in trying to place the steel in the girders owing to their depth; this, however, was overcome by assembling the steel frame and wiring it thoroughly together above the girder form, and then lowering it into place with block and tackle. The remainder of the reinforcing offered very little resistance to rapid placing.

The sidewalk fencing was erected by casting the concrete posts in place together with the 3-in. iron pipe hand-rail. After the forms were removed the iron fence was put in place and bolted. The fence has provision for expansion at each post, thus avoiding all danger of buckling out of line from the heat.

The lamp posts are of concrete cast in place, the wiring being placed in loricated iron tubing concealed in the concrete.

Costs.

The bids for this work varied from $7,127 to $14,114. The successful bid amounted to $12 per cu. yd. for concrete including all falsework and forms, and 3 cts. per lb. for steel in place.

The following is a list of the unit costs of the bridge. As prices of material and labor differ widely in various parts of the country, the lumber costs have been reduced to feet B. M. per cu. yd. of concrete, and the labor to hours per cu. yd. of concrete:

Labor hours per cu. yd. of concrete—14 hrs. (includes foreman's time reduced to the basis of laborers' time.)

Carpenter labor hours per cu. yd. of concrete—4.6 hrs.

Lumber for formwork—90 ft. B. M. per cu. yd. of concrete.

Labor hours, handling, bending and placing twisted steel—0.0373 hrs. per lb.

The above figures are exclusive of falsework, temporary footwalk, fencing, teams, etc. With a more efficient plant and management, these figures could possibly be reduced 10%.

The designing of this bridge and supervision of construction were done by the writer, under the direction of Mr. Clinton Cowen, County Surveyor, and Mr. Hugo Eichler assisted in the design and checked all computations.

Pennsylvania Coal Mining in 1909.*

The production of coal in Pennsylvania during the year 1909 has been compiled by the U. S. Geological Survey in cooperation with the Census Bureau, and statistics will be soon published as advance chapters of the "Mineral Resources of the United States, 1909." The publication of this matter has been long delayed on account of the conditions of cooperation between the Survey and the Census Bureau.

TOTAL PRODUCTION.—In 1909, Pennsylvania produced 47.7% of the total coal mined in this country. Up to 1902, Pennsylvania had always produced over half the national coal output. It is doubtful if Pennsylvania in the future will contribute more than half of the country's total. In 1880, this state produced 60% and during the last 25 years has produced about 53% of the total. Pennsylvania produces more coal than any other county in the world except Great Britain, and in fact its production exceeds the combined production of all countries outside of Great Britain, Germany and Austria Hungary. Compared with 1908, the 1909 production showed an increase of 18,557,669 tons, or 9%. This increase was entirely in the production of bituminous coal.

ANTHRACITE.—The anthracite mining began in 1814, when some 22 tons* were produced for local use. The year 1820, however, is usually considered to mark the beginning of the industry, as in that year 400 tons were shipped out of the region. From 1814 to 1910 the total anthracite production amounted to 2,095,838,234 tons. The production of anthracite declined from 83,268,754 tons in 1908 to 81,059,159 tons in 1909. Thus it is seen that the increase was due to the bituminous product only.

BITUMINOUS COAL.—The rapid growth of bituminous-coal production compared with anthracite has been marked.

The first records of bituminous-coal production in Pennsylvania are for the year 1840, when 464,826 tons were mined. The total output of bituminous coal from 1840 to the close of 1909 has amounted to 2,101,215,571 tons, from which it appears that the total production of anthracite and of bituminous coal in Pennsylvania has been nearly equally divided between the two. At the close of 1908 the total production of anthracite from the earliest time to the close of that year had exceeded the total bituminous production by about 51,000,000 tons. As, however, the production of bituminous coal in 1909 exceeded that of anthracite by more than 56,000,000 tons, the total production of bituminous coal now exceeds that of anthracite.

Comparing the figures for anthracite and bituminous coal, the average production of anthracite during the five years from 1901 to 1905 was 2.59 times the average yearly production from 1876 to 1880, and the production of anthracite in 1909 was 3.14 times the average annual production from 1876 to 1880. The tonnage of bituminous product from 1901 to 1905 was 7.5 times that of the output from 1876 to 1880, while the production in 1909 was 10.4 times that of the average for the five years from 1876 to 1880.

EMPLOYEES.—It is reported that 171,195 men were employed in the anthracite mines of Pennsylvania in 1909, working an average of 205 days each. The bituminous mines employed 185,921 men for 210 days. The average production per man per year in the anthracite region was 474 tons. In the bituminous mines the similar figure was 742 tons. In 1908 there were 174,174 men in the anthracite mines and 165,961 men in the bituminous mines. The average annual productions per man for 1908 were 478 and 706 tons for the anthracite and bituminous mines respectively.

ACCIDENTS.—Different inspection laws govern the anthracite and bituminous mining operations in Pennsylvania and statistics are compiled separately for the two industries. It is shown that mining is more hazardous in the anthracite region than in the bituminous, although a larger number of men have been killed by explosions of dust and gas in the bituminous than in the anthracite mines. From 1885 to 1900 inclusive, there were 11,491 fatal accidents in the anthracite mines and 6,962 in the bituminous mines. The non-fatal accidents in the bituminous mines have been reported only since 1889, and in these 21 years 13,935 men have been injured. During the same period the injuries received in the anthracite

*From an advance bulletin of the U. S. Geological Survey.

*Tons of 2,000 lbs. are reported in all cases.

FIG. 4. VIEW OF FINISHED BRIDGE.

mines were 23,973. Of the 11,491 deaths in anthracite mine accidents in the 25 years noted, 874, or less than 8%, were due to explosions of gas. In the bituminous mines 1,067 out of 6,366 since 1891 were due to explosions of gas or dust; that is, the percentage is about double that for the anthracite mines. Falls of roof or coal killed 5,001 men in the anthracite mines in 25 years and 3,909 in the bituminous mines in the last 19 years, or an average of 200 and 205 per year respectively.

In both classes of mines there was a decrease in fatal accidents in 1909 over 1908. There was a decrease in the number of injuries in the anthracite mines, but an increase in the number of injuries in bituminous mines. The number of fatal accidents in the anthracite region in 1909 was 567 compared with 678 for 1908. The non-fatal accidents here numbered 1,034 in 1909 and 1,170 in 1908. In the bituminous mines, these figures were, respectively, 506, 572, 1,126 and 1,019. Falls of roof and coal in anthracite mines during 1909 killed 254 men, and in the anthracite mines 291. In bituminous mines 48 men were killed by dust and gas explosions and 28 in the anthracite mines.

The more fatal character of explosions in the bituminous coal mines is intimated by the fact that, in a period of 25 years, 874 men were killed by gas explosions in the anthracite mines where dust is not a dangerous factor, and the number of men injured from the same cause was 2,942. Compared with this during a period of 17 years, explosions in the bituminous mines, where dust is a dangerous factor, killed 955 and injured 303. The annual averages are 35 killed and 118 injured in anthracite mines, compared with 56 killed and 17 injured in the bituminous-coal mines.

The death rate per 1,000 men employed in the anthracite mines was 3.32 and in the bituminous mines 2.72. This means that 142,961 tons of anthracite and 272,661 tons of bituminous coal were mined for each life lost.

Skew Abutments for Deck Plate Girders on the Western Maryland R. R.

In order to avoid the usual skew end connections and occasional skew lateral systems which are necessary on plate-girder bridges where the line of the bridge is at an acute angle with the shore line of the stream crossed, Mr. H. R. Pratt, Chief Engineer of the Western Maryland R. R., has adopted for all such bridges on the new Cumberland-Connellsville extension of his road, the type of abutment shown in the accompanying view. This, it will be noted, consists of a plain concrete solid section, up to the level of the bases of the girder shoes, following in general the direction of the river bank as far as the center line of the bridge and then turning to run at right angles with that center line. Above that bench level thin walls of the abutment are carried up to the track level on a jogged line, which forms two back walls against which the girders back and which are at right angles to the center line of the bridge. In the case illustrated provision is made for a two-track bridge and each track is carried on a two-girder span, with the girders of each span of the same length and with even ends, but with one span moved along the line beyond the other a sufficient distance to care for the skew.

A SPECIAL TYPE OF SKEW ABUTMENT ON THE CONNELLSVILLE-CUMBERLAND EXTENSION OF THE WESTERN MARYLAND R. R.

In the bridges on this extension the girders rest on shoes on the main bench and the plate on the top face of the end floor beam is just on a level with the top of the back wall. Across this bench, and resting on it, is placed a heavy rail, extending well into the side walls on either side, as shown on the view, and this rail serves to hold back the ballast from the main track. The rail is further held tight in the concrete by a bent strap, embedded in the concrete at each end, and passing over the top and bottom of the rail, reaching out as a brace, in the line of the bridge. The bridges are all built with an open floor system with the ties resting on closely spaced floor beams and the rails at the abutment span over from the ties embedded in the ballast of the main track to the end tie of the bridge. This square ended connection grooves more serviceable from a maintenance standpoint than does the usual skew connection, which requires much more attention owing to the spreading effect of moving trains entering the bridge.

Improvement of the Port Facilities of Philadelphia.

The city of Philadelphia has 33 miles of water front, with a depth of 18 ft. or more, 18.8 miles of which are on the Delaware River and the remainder on the Schuylkill River. Yet not until three years ago, when the Department of Wharves, Docks and Ferries was created, had the municipal authorities taken any definite steps for increasing the port facilities of the city.

The work which this new department has accomplished, and has planned, was described in the October number of the monthly bulletin which is published by the municipal government.

Public sentiment in Philadelphia has become aroused on the subject of the city's commercial facilities, and liberal amounts of national, state and city funds are now available. The Federal Government has recently completed a 30-ft. channel from the city to the mouth of Delaware Bay. The legislature of the state has repealed certain old laws which hampered the city in undertaking municipal dock construction.

The plans now under consideration provide pier accommodations for 131 ships 600 ft. in length and warehouses with a total floor space of 44,539,500 sq. ft. The proposed new docks have a total length of 17.06 miles, and affect an area of land, exclusive of railroad yards, of about 1,015 acres.

The city owns 13,456 ft. of frontage on the Delaware River and 11,180 ft. on the Schuylkill River, in 75 different locations.

The main plan of improvement has to do with the Schuylkill River. Here it is proposed to build a channel 800 ft. wide through Point Breeze, opposite Passyunk Ave., and between that point and the League Island Navy Yard to construct 14 piers and docks on the west bank, and 8 piers and docks on the east bank. Most of these piers would be 1,300 ft. long. Those on each side would be connected by belt-line railways. The channel width between pier heads, as designed, is 800 ft. These plans give a total length of piers of 10.27 miles; the sheds and warehouses would have a total area of 630 acres of floor space. The plans include the building of a concrete bulkhead, reducing the width of the river and increasing the channel depth, and filling in the lands back of the bulkhead with material removed in the construction of the channel and docks.

The actual work thus far accomplished by the Department of Wharves, Docks and Ferries has consisted chiefly in the dredging of 758,545 cu. yds. of material from existing docks and work upon a new city pier and bulkhead under construction at Vine St. at a total cost of $421,000.

By no means the least important work of the Department is keeping the channel of the Delaware open during the winter months, and this includes not only the city's own 20 miles, but the entire distance of 90 miles to the entrance of Delaware Bay, besides some miles above the city.

This work is performed by three ice-breaking boats, No. 1, built in 1837; No. 2, in 1868, and the "John Weaver," built in 1905. This last is a powerful boat capable of a speed of from 9 to 10 miles per hour through 10-in. ice. It is equipped with 5,000-HP. engines, with two screws astern and one in the bow. During the season of 1909 these ice-breakers assisted 134 vessels which had become ice-bound, including the U. S. Battleship "Idaho."

The following statistics of the cities which are Philadelphia's chief commercial competitors, are taken from the Report of the Commissioner of Corporations on Transportation by Water in the United States, and from the U. S. Census Reports on Industrial Districts.

Boston has about 12 miles of water front in active use and a 35-ft. channel to the sea. In the entire metropolitan district there are 210 wharves with a frontage of 98,000 ft. The ownership of the water front is largely in private hands, a large area consisting of railroad holdings. The city owns only a few scattered and unimportant wharves, most of its water front being used for park, municipal and ferry purposes. The administration of the harbor is in the hands of three commissioners who form the Massachusetts Board of Harbor and Land Commissioners. The rate of increase in value of the manufactured products of the Boston district, between the years 1900 and 1905, was 29.2%, according to the U. S. Census reports.

New York has 445 miles of water front, 55 miles of which are now in active use. It has a 40-ft. channel to the sea. New York differs from the other Atlantic ports in that a large portion of the most important water front with its wharfs and piers are municipally owned. The city now owns practically all the North River front from 67th St. to the Battery, and on the East River, as far north as Corlears Hook Park. It also owns a considerable section on East River, between E. 16th St. and E. 29th St. In Brooklyn the city holdings are limited mainly to Wallabout Basin. Of the 180 piers between W. 70th St. on the North River to E. 42d St. on the East River, the city now owns (1910) about 150. The water front is in charge of the Department of Docks and Ferries, of the city, which spends annually about $2,500,000 for salaries and maintenance, exclusive of new construction. The rate of increase in value of the manufactured products of this district between 1900 and 1905 was 32.8%.

Baltimore has about 18 miles of water front and a 35-ft. channel to the sea, which, however, has been only recently completed. Its harbor facilities are notably cramped. The city owns only 9% of the water front, the railroads 17% and private interests the remaining 74%. Within the last 6 years the city has been actively engaged in the building of six large piers and bulkheads and in widening adjacent streets. Up to 1910 the sum thus expended, including the purchase of water front amounted to about $6,500,000. The administration of the harbor in the hands of five members of the Harbor Board, appointed by the mayor. The rate of increase in value of the manufactured products of this district between 1900 and 1905 was 14.6%.

At Philadelphia the railroads own 45% of the Delaware River water front and occupy considerably more. On the Schuylkill River they now own about 9,500 ft. The rate of increase in value of the manufactured products of the district of Philadelphia between 1900 and 1905 was 16.3%.

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As reported last week, both Houses of Congress have now passed the Burkett bill providing a federal bureau for the inspection of locomotive boilers. We criticized this measure a year ago on the ground that the responsibility for the inspection and proper safety of locomotive boilers ought be left with the railway companies. As now enacted, however, the bill has been radically amended so that the railways have the primary responsibility for care and inspection of boilers. The duties of the federal inspectors are to see that the railway inspection is thorough and effective and is properly maintained.

The provisions for the organization of the bureau are well drafted. The whole country is to be divided into 50 districts, and a federal locomotive boiler inspector is to be stationed in each of these. The salaries provided for are liberal—$1,800 a year, with allowances for traveling and other expenses, clerk hire, and office rent. The inspectors are to be selected by Civil Service examinations, so that it should be possible to obtain a force of thoroughly competent men.

The most surprising thing about this law is that Congress should be willing to provide for this large extension of federal supervision over railway operation merely to guard against one single source of danger, and that one of the least important in connection with the railway service, while it ignores the need for federal inspection with regard to railway safety in general.

This journal and other prominent journals in the railway field have for years urged that the federal government should establish a bureau for the systematic investigation of railway accidents and the promotion of safety in the railway service on similar lines to the work conducted so successfully for many years by the Board of Trade in Great Britain. Such a bureau, efficiently organized, would be welcomed by the railway companies, as well as by the public, and could obtain results of enormous value in the saving of lives and limbs.

It is interesting to contrast the figures of casualties by locomotive boiler explosions and by other accidents in the railway service. The statistics published in our issue of June 30, last, showed that the average casualties per annum in the United States by locomotive boiler explosions are, in round numbers, about 50 persons killed and 100 injured. In comparison to this, the casualities from railway collisions and derailments alone, in the last year for which the Interstate Commerce statistics are available, were 824 persons killed and 12,782 persons injured. In the same year the casualties from all causes in connection with the movement of railway trains and cars were 9,851 persons killed and 64,714 persons injured.

Congress has seen fit to appropriate $300,000 to establish a federal bureau to bring about greater safety with respect to locomotive boilers. We believe that an equal amount provided to establish a bureau with power to investigate railway accidents and promote railway safety in general would have ten times to one hundred times as great results in saving lives and limbs.

We would call attention to the article by Mr. E. O. Gast on another page of this issue describing the novel type of reinforced-concrete arch bridge which has been recently completed near Cincinnati, O. In a number of places in Europe the more daring, or perhaps it would be better to say, the more advanced concrete designers, such men as Mr. Considère of hooped column fame, have built a number of arch bridges of the through type, in which the load is carried to the rib through hangers, though we know of none in which the arch thrust is resisted by horizontal ties rather than by heavy abutments. In this country the nearest approach to this type of design is the Broadway or Sparkman St. Bridge at Nashville, Tenn., which has been thoroughly described in past issues of this journal. Two of the spans in that bridge are of the so-called bow-string truss type and are of reinforced concrete, but the absence of any diagonal members in the trusses makes them closely resemble the tied arch such as has been built over Millcreek. The main difference is that the roadway of the Nashville spans is carried to the arch rib, or more properly, the curved upper chord, from an upper deck supported on posts in pure compression.

One criticism will always lie against this type of bridge. It is partly theoretical, and as such cannot be controverted any more easily in the future than now; in so far as it is practical, service can only prove its validity. That criticism concerns the tension members that must always be a part of the reinforced-concrete truss or tied arch. Theoretically, the design of a pure tension member of concrete, whether reinforced or plain, is uneconomical. If plain, the required size is impossible; if reinforced, it is only the steel that does any work and the concrete covering, demanded by artistic considerations to balance the rest of the concrete structure, is far too voluminous to satisfy mere protective requirements, besides adding considerably to the dead load of the bridge. Practically, we can look with considerable concern at the tied connections between the various tension members of the bridge. In the Millcreek arch the greatest attention has been paid to the intertwining of the rods at the top and bottom of the hangers and at the connection between the horizontal tie and the arch rib, but suspicions that can only be set at rest by long service must be aroused by the thoughts of the possible effect of the racking impact of a speeding 40-ton car over this suspended roadway. It may be that we underestimate the ability of old, slender concrete members to resist this impact, but the suspicion remains.

Aside from these considerations, it remains that another remarkably economical bridge has been built. Some weeks ago we called attention to a long concrete trestle bridge that had been built at a cost of $2 per sq. ft. of road surface. The Millcreek bridge, thanks partly to the use of the old abutments, cost about the same. It is not so long ago that unornamented concrete bridges were being estimated, for the preliminary project, at from $3 to $5 per sq. ft. of road surface. Such figures are, of course, of only superficial value, but even as such, they indicate a growing ability to build concrete structures.

A Bill to Increase the Cost of Advertising.

By a clause which has been inserted in the Post Office Appropriation bill by the Senate Committee on postal matters, the rate of postage on the advertising pages of all magazines will be increased to 4 cts. per lb. after June 30 next, if the bill is enacted in its present form. This is an increase of 3 cts. per lb. over the present rate.

As each page of Engineering News represents a weight of about 150 lbs., with its present edition of some 18,000 copies, this means that our postage bill will be increased every week by about $4.50 for each page of advertising carried, or on an average issue with 100 pages of advertising about $450. This means that the prices for advertising space to an advertiser who contracts say for a page of space for a year must be raised about $235.

The argument presented in support of this measure is, first that the present rate of one cent a pound on second-class matter does not pay the government the cost of handling it, and second that the loss is chiefly on the magazines of general circulation which are carried long distances and not on the newspapers which have chiefly a local circulation.

We have heretofore expressed our cordial approval of the work Secretary Hitchcock is doing to place the Post Office Department on a sound business basis. We have no question that the Administration in urging this increase in the postal rate and using its influence to secure approval by Congress is acting in what it believes to be the public interest. There are certain facts, however, to which Congress ought to give due consideration before it enacts this bill.

Briefly summarized, the proposition is to charge a higher rate of postage on the advertising pages only. There is no increase on the postage on reading matter pages, nor on advertising portions of newspapers. The justification for the higher rate on magazines is the fact that they are carried over greater distances.

There is a fallacy in this argument, and the fallacy is that the cost of carrying mail is proportionate to the distance it is carried. A year ago, as our readers may recall, we showed in these columns that in the carriage of ordinary merchandise freight, the cost to the railways of handling in terminals is often far greater than the cost of hauling over the road. In an example cited, we showed that the cost of terminal handling alone on a merchandise shipment between New York and Philadelphia may be a dozen times as great as the cost of hauling over the road.

Now if the cost of handling barrels and boxes of merchandise in a terminal is so much greater than the cost of hauling them over the road, how much more is the cost of handling and distributing mail matter, composed of pieces most of which weigh less than an ounce, greater than the cost of hauling the matter from terminal to terminal!

But, it is said, the railways are paid for mail transportation on the basis of the number of pounds carried and the number of miles covered. That is true and it is true because the old time method of payment for carrying the mails, followed in the days of the stage-coach, has been applied without change in principle to the payment for carrying the mails by rail.

Because an antiquated method of railway mail payment, which has no relation whatever to cost of service, is in force, it should not be made the basis of a change in the rates of postage charged. Two wrongs do not make one right.

We are not here alleging that the railway mail payments are excessive. What we do say is that the basis on which they are made is so utterly remote from the cost of furnishing the service that nobody on earth can tell whether the rates of railway mail pay are fair or not.

Actually, what the railways do for the post office is to furnish certain cars, or space in cars, for the carriage and DISTRIBUTION of mail matter.

It is these cars and the space in them that should be paid for. It makes no difference in cost to the railway company whether the cars carry 500 lbs. of mail or five tons.

But why does the post office require so much

space, in these cars for its railway mail clerks? It is because of the *number of pieces* of mail matter which they have to distribute. In other words it is *not the pounds* of mail matter carried or the distance carried that forms the main burden of cost on the post office. It is the number of pieces which have to be collected, sorted, handled and finally delivered to the addressees.

Of course we are speaking broadly. There is undoubtedly a certain small increase in the cost of handling a magazine weighing a pound over one weighing an ounce. There is an increase in cost in carrying a magazine a thousand miles compared with a hundred miles. But we say emphatically on whatever authority may be due to years of familiarity with and study of questions of economic transportation, that any such increase is extremely small and that rates of postage on all classes of mail matter ought to be based on *the number of pieces mailed* as well as upon the weight.

We agree with the Post Office Department that the present rate on second-class matter of 1 ct. per lb. is probably below the cost to the Department of handling; but the Department's estimate of 9 cts. per lb. as the cost of handling this matter is based on the fallacy above pointed out and is, we are confident, many times the actual cost.

We believe the proper way to increase the rates on second-class matter is to add a fixed charge for each copy mailed to the present pound rate. This should be done, even if the pound rate itself were to be increased.

We believe we express the general sentiment of reputable publishers in saying that they are willing to pay the actual cost to the post office of handling their periodicals and will raise no opposition to a measure which will do this and which will treat all alike.

But the Post Office Department ought not to have the function of standing as a censor over publications. It is a dangerous thing to hamper in any way the freedom of speech or the freedom of the press. And it has been well said that the power to tax may be made the power to suppress.

Where will the post office draw the line between a newspaper and a magazine? The Courts will have to undertake that task without doubt, if the law is carried into effect. And if a line can be and is drawn, its inevitable result will be to place a premium on the circulation of matter printed on loose sheets of poor paper and to restrict the circulation of the high class publications which are well printed and properly bound.

Again, the Department will have the burden of passing on every issue of every publication, and counting the pages on which advertisements appear in whole or in part. To carry out the law fully, it would even have to scrutinize the text for trade "write-ups," if such a procedure were feasible or permissible.

Those who have watched the last quarter century of journalistic progress know how hard a fight has been made to secure the complete separation of advertising from reading matter and to eliminate the insertion of advertisements in the guise of reading notices. The new postage rates will pay a premium to the publisher who accepts payment for trade write-ups, which are circulated as reading matter at the minimum postage rate.

We refrain from taking further space to discuss this proposed law; but we do wish to emphasize that when Congress makes a change in the second-class postage rates, it should make it on sound and well-considered lines. The proposal to treat arbitrary classes of publications on a radically different basis is a new departure which may be fraught with much greater danger than is now realized.

We would raise no word of opposition to any move to make more business-like the conduct of the postal service or to increase the rates on any class of mail matter to a point that shall be fairly compensatory. It is because we believe the present measure to be based on fallacious estimates and ideas, and to produce unfair discrimination and the lowering of the standards in the publishing field, that we hope to see it defeated or at least radically amended.

The Plant for Building the Gatun Locks at Panama.

We give extended space in this issue to the plant which is now at work on the construction of the Gatun locks for the Panama Canal. This plant is well worth description, not only because of its novel features but because of the record-breaking magnitude of the work and the astonishing progress it is making. We doubt whether engineers in general at all realize what a great advance the work at Gatun represents over anything ever done before. The public have become so accustomed in recent years to the term "millions," in the quantities and costs on great engineering works, that the real immensity of the work at Panama is hardly appreciated.

The mere figures showing the volume of masonry make no impression on the mind of the average man, and hardly on the mind of the average engineer. It is only by comparison with familiar objects that one can appreciate what the figures mean.

Suppose the concrete to be laid in the Gatun locks were deposited in a broad city street 100 ft. in width and of a depth to fill the street solidly to the height of four-story buildings alongside, say 40 ft. A block of concrete 2½ miles long of these dimensions would have the same volume as the concrete which the Gatun locks will contain. Thus there is enough concrete in the Gatun locks to fill Broadway, New York City, with concrete from City Hall to Madison Square with a depth of 40 ft.

When the lock plan was adopted at Panama, only five years ago, the engineers responsible for it, as well as those who opposed it, realized the immensity of the task.

Critics of the lock plan at that time declared that the amount of masonry in those huge locks was so vast that nobody could tell how many years it might take to construct them. The minority of the Board, which recommended the lock plan, took a more hopeful view, although they admitted that the work was record-breaking in size. Quoting from their report:

> The amount of concrete masonry required for the Gatun locks will be about 1,300,000 cu. yds. This would be the greatest mass of masonry built in modern times. It will require special organization and the best plant.

Assuming such an organization and plant, the Board concluded that there was nothing impossible in the assembling of materials and the construction of the locks with such speed that they could be completed at as early a date as any other portion of the work.

Since the lock plan was adopted, however, changes have been made in the size of the locks which have greatly increased the amount of masonry involved. Instead of the 1,300,000 cu. yds. contemplated in 1906, the amount of masonry in the present locks at Gatun is 2,085,000 cu. yds.

It may be of interest to see how this huge mass of masonry compares with some of the other huge masonry works which have been built in recent years. Probably the largest works in masonry at all comparable with the lock work at Panama are the large masonry dams constructed in recent years.

Taking a few typical examples, the Wachusett dam, constructed to store water for the supply of Boston and its suburbs, contains 273,000 cu. yds. of masonry, or only about one-eighth the volume of the masonry in the Gatun locks. It required about five years for its construction.

The Roosevelt dam, on the Salt River Reclamation Project in Arizona, which is just being completed, contains about 340,000 cu. yds. of masonry and has taken about five years to construct. The Assuan dam, on the River Nile, contains about 704,000 cu. yds. It was building during the years from 1898 to 1902.

All these dams, however, are structures of simple design compared with the canal locks, and a more direct precedent for the work at Panama may be found in the Poe lock at Sault Ste. Marie. This contains 81,000 cu. yds. of masonry, and about eight years were occupied in its construction.

Certainly, if the time required to build any of these structures were to be taken as a precedent for the time required to place the more than 2,000,000 cu. yds. of masonry in the Gatun locks, there was much ground for saying, five years ago, that the time necessary to build the canal locks of Panama would be so great that the completion would be delayed beyond the time necessary to construct a sea-level canal.

Now let us turn to the progress record which has thus far been made on the Gatun lock construction. As was foreseen when the lock plan was adopted, a long period was required for excavation work on the lock site before actual construction could begin. The lock plan was adopted in 1906, and it was more than three years afterward before actual laying of concrete began at Gatun, on Aug. 24, 1909. It was not until Oct. 1 that the concrete plant was able to show a large output. Only about 13,000 cu. yds. had been laid up to Oct. 1.

The months of October and November each showed a record of about 30,000 cu. yds. This output was steadily increased, month by month, until in June, 1910, an output of 89,400 cu. yds. was reached. The work has proceeded since with monthly outputs of 75,000 to 85,000 cu. yds., and on Jan. 21, 1911, a total of 1,051,723 cu. yds. had been laid, which is over 50% of the entire amount required to complete the locks. In other words, it has only taken a period of 15 months since the work was actually underway to lay half the total volume of masonry in the locks.

No record even approaching this has ever been made anywhere. The nearest approximation that we can now recall was the concrete work on the McCall's Ferry dam, where a concrete plant was installed which at times reached an output as high as 2,000 cu. yds. per day.

The first reason that impresses one as an explanation of the rapid progress on the Gatun work is the use of concrete instead of stone masonry. We presume most engineers familiar with construction-work appreciate the advantage of concrete over ashlar or rubble masonry so far as cost is concerned, and also to some extent with respect to the rapidity of construction; but we believe the enormous contrast shown above between the time required to build large masonry dams and the speed attained on the Gatun locks, will impress every engineer.

It is said that the late William H. Brown, for many years Chief Engineer of the Pennsylvania R. R., who always preferred to build structures of stone rather than of concrete, used to explain his opposition to concrete with the remark that he could not see the sense of chopping stone into little pieces for the sake of sticking it together again with cement.

It requires only a glance at the enormous use of concrete in railway work to-day to perceive the fallacy of such a remark as that just quoted. It seems to us that the great advantage of concrete over stone masonry with respect to speed of construction has never been so forcibly brought to the attention of the engineering profession as it has by this work at Gatun.

We have quoted above the remark of the International Board of 1906 with respect to the special organization and plant that would be required at Gatun in order to secure the necessary speed of construction. The plant, which is described in this issue, is well worth study by engineers. It is an illustrration of how a dozen or twenty pieces of apparatus and machinery may be brought together to operate as one complete system. The two most notable features of the Gatun plant are the automatic electric cars which carry the concrete materials from storage to the concrete mixers, and the traveling cableways which take the mixed concrete from the industrial railway, running the length of the lock site, and place it at any desired point in the lock pit.

Another most important and notable feature, well worth attention in the design of any plant of this sort, is the provision for storage of the materials. It is impossible to make any system of transportation operating over a large area operate with clock-work uniformity. Besides, the disposition of the mixed concrete is subject to great variations according to the part of the work on which construction is proceeding. In the design of this plant, therefore, a large amount of storage was provided so that each elemental part can proceed at its best pace without inter-

ruption, and not be delayed by having to wait for the progress of some element ahead of or behind it.

It will impress the reader, doubtless, as it has us, that considerable boldness was required to decide upon the selection and installation of this huge construction plant, involving some elements, like the automatic electric cars, which had been hardly ever used before and not at all in such a situation. The good judgment of the designers, and indeed of the entire responsible engineering staff, has been justified, however, by the magnificent record of output which the plant has attained.

LETTERS TO THE EDITOR.

The New York City Water Department and the Forced Resignation of Deputy Commissioner Bemis.

Sir: The article on "Recent Waste-Detection and Meter Work in the New York City Water Department, by Mr. E. W. Bemis, until recently Deputy Commissioner of Water Supply, Gas & Electricity of the City of New York, and the accompanying editorial comment, in your issue of Jan. 12, 1911, present many conditions affecting the conduct of municipal affairs that would appear to be a reproach to any community by reason of political as distinguished from business management of a great municipal department closely in touch with the people.

In commenting on the article and on existing conditions in the water department you strongly emphasize the necessity for a radical change of methods as applied to the water problems which continually confront the people of this great city. Particularly is a change needed, in view of the great waste of water, enabling those in authority to raise the senseless cry of "water-famine," so detrimental to the interests of the city at large.

A remarkable thing about the article by Mr. Bemis is the entire absence of slur or criticism as to his summary removal from his position. The true story of meanness practiced on him has never been told. To say that it was inhuman, would not overstep the limit. Mr. Bemis's well-known reputation as an expert—evidenced, among other things, by his long experience and success in the Cleveland Water Department—and his loyalty to the people of New York, whom he came to serve, at the instance of Mayor Gaynor, were deserving of something better.

Certain it is, that Mr. Bemis' experience here during a part of the year 1910, in connection with the water-supply system and the balking of his efforts for improvement, would make an interesting chapter. Particularly so, in the light of facts as he presents them, and the explanation made by Commissioner Thompson when selecting a man to succeed Mr. Bemis, after his summary removal, that there were about 800 documents to be passed upon and signed, daily, by either himself or his Deputy. The wonder is that Mr. Bemis, under such conditions—for his was the laboring oar—could give the subject of "Waste Detection and Meter Work" any attention whatever.

Under the sub-head "Testing Large Meters," Mr. Bemis wrote:

* * * * * *

Of the 408 meters larger than 1-in. that were tested before October, 59 were found to be fast, 96 were slow, and 253 were correct within 2%. While testing these 408 meters, 27 others were found that did not register at all, of which 4 were 1½-in., 9 were 2-in., 2 were 3-in., 6 were 4-in., and 6 were 6-in. * * * At this rate there must be over 700 large meters in the city not recording a drop of the large amount of water daily passing through them.

* * * * * *

There was a net loss to the Department of $16,379, or $40.14 on the average for each of the 408 large meters tested. If this average rate of loss applies, as seems likely, to the entire 11,487 large meters of the city, the total yearly loss from under-registration is $461,088.

* * * * * *

Again, Mr. Bemis, under the sub-title, "Testing Small Meters," says:

* * * * * *

Prior to Oct. 1, 232 small meters in Brooklyn were taken out, tested, repaired where necessary, and reset. Of these meters, tested as they came, 33, or 13%, did not register at all, and 52, or 21%, did not register on a 1/16-in. stream. * * * If the same ratio holds throughout the city about 8,000 ⅝-in., ¾-in., and 1-in. meters are *hors de combat*, while a still larger number are scarcely registering half the water passing through them

* * * * * *

These are shocking conditions, and they call for prompt remedy.

Of course, had Mr. Bemis's article been in the form of an official report to the Mayor, or the Department, the accompanying data would have given in detail the trade name, number and size, of all meters—large and small—thus tested and found wanting; and, likely, would have stated the period of service of each. Very important things to know. While these items would not necessarily reflect on the use of water meters as preventives of water-waste, thus conserving an existing supply, and avoiding the need for expensive installations of pumps, etc., or deferring the occasion for such for many years, with the incidental production of greater revenue, meanwhile, they would surely indicate which of the dozen or more makes of water-meters admitted to the list of those adopted for purchase and use in the City of New York, during the past 25 or 30 years, are now worthily there, and which are not. In other words, the designation of "the fittest" as to accuracy, efficiency and length of service, and possibly as to cost of maintenance, would necessarily be disclosed. It is altogether likely that the long experience of Mr. Bemis at Cleveland, and during his shorter stay here, has given him some knowledge on that subject. And this ought to become public property in the interest of the people and that of good government, alike. I may suggest here that it can come none too soon.

Little wonder that you use the words "General Inefficiency of the Water Department of New York City" as a caption to your editorial, from which I quote, as follows:

It looks very much as if nothing short of an earthquake in the New York Water Department would be sufficient to dislodge the inefficiency and almost criminal wastefulness which, with brief spasmodic exceptions, has prevailed there, lo these many years. Archaic appliances and methods are still standard; waste goes on practically unchecked; inefficiency runs riot through the whole department.

* * * * * *

This arraignment is severe, but deserved. Surely, you hit the nail upon the head more than once. It is well to remember, however, that there are other cities which, in the handling of their water-supply, are equally to be condemned for criminal waste and lack of proper business management. New York City is not alone in being victimized by inefficiency "or worse" in the conduct of its Water Department. Philadelphia and Chicago may well be cited as among other large cities, deserving like censure. The shortcomings are not confined to New York, that is sure.

Mayor Gaynor is absolutely right in desiring to see the City of New York upheld in its greatness and treated fairly in all things before the world. Under his administration, many improvements, plainly apparent, so that "he who runs may read," have come about in the way of better government based on honest business lines. Even his enemies should credit him to that extent, while his friends, whose name is "legion," will continue to "love him for the enemies he has made."

I may say, in conclusion, that in respect of general "knocking" and belittling our great City—resorted to altogether too frequently for reasons of spite alone, by "calamity howlers" and others who should be regarded as public enemies—the writer has no sympathy whatever. It is different, though, when a technical journal of high standing such as the Engineering News, feels called upon to make criticisms already mentioned and concludes its editorial comment, as follows:

"Occasionally, say once in five to ten years, some official arouses himself and risks his official life by making some effort toward reform. But when such a phenomenon does appear he is either allowed to batter his head helplessly against the adamantine apathy of some somnolent superior officer or else his head is quickly and neatly removed by the political guillotine. We venture to suggest that the Water Department might well be put under the Department of Charities. That is the proper place for asylums."

Respectfully yours,

Brooklyn, N. Y., Jan. 30, 1911. 'Engineer."

[A perfectly frank and full statement of the cause of the forced resignation of Mr. Bemis, just as he was getting well started on the reforms which he was brought to New York by Mayor Gaynor to undertake, would make interesting reading. Such a statement would not be complete unless it was joined in by many persons, including Mayor Gaynor, Commissioner Thompson, and Mr. Bemis, as the three principals, and in addition certain division heads in the water department, and various contracting interests outside the department.

One point in our correspondent's letter deserves attention. The large number of slow and non-registering meters found by Mr. Bemis does not necessarily reflect upon any type or make of meters. The best mechanical device ever made will go wrong or go on a strike if it is given no proper care for years, as appears to have been the case here.

We believe that there are engineers in the New York Water Department who realize its many shortcomings and would like to see them remedied. The trouble is that these men lack authority to put needed reforms into effect on their own initiative and have not sufficient strength of character and devotion to principle to persist in their demands for reforms at the risk of losing their positions.—Ed.]

An Official Statement Regarding Progress and Increased Efficiency in the Department of Water Supply, New York City.

Sir: In your issue of Jan. 12, 1911, there is an article by Mr. E. W. Bemis, former Deputy Commissioner of this Department, on which an editorial is partly based stating that the Water Department of New York City (with particular reference, apparently, to what are now designated as the Boroughs of Manhattan and The Bronx) is generally inefficient. The following quotation from the editorial illustrates its general tone:

Archaic appliances and methods are still standard; waste goes on practically unchecked; inefficiency runs riot through the whole department.

The old proverb, "give a man a bad reputation and it will hang him," is evidently also true when applied to a municipal department in some of our Boroughs, as it seems impossible to obtain recognition for honest, efficient work where inefficiency has ruled in the past. The editorial in Engineering News would leave in the minds of its readers an entirely erroneous impression as to existing conditions in the Water Department of New York City. Realizing that a journal of the standing of Engineering News would not intentionally misstate facts, I deem it proper to bring them to your attention.

Active work has certainly been carried on and is now being prosecuted to the fullest extent of the means available in order to improve the management of the Department in Manhattan and The Bronx, and modernize its equipment. Since the writer, who had been in charge of the engineering work in Brooklyn, upon which you favorably comment, was put also in charge of the Engineering Bureau for the Boroughs of Manhattan and The Bronx, five years ago, considerable progress has been made in the Department in various directions. With reference to the engineering work, for instance, the following items may be noted:

Completion of studies and submission of detailed report on the filtration of the Croton water-supply with recommendations for the installation of the plant.

Installation of a modern sewage-disposal plant at Mount Kisco, thus adequately protecting the supply from the dangerous sources of pollution which so long have existed there.

Important improvements in the pumping plants and systems of maintenance and operation, resulting in a large reduction in cost, to which further allusion will be made.

Reinforcement of the distribution system by proper extension and connections, considerably increasing the efficiency of the supply both for domestic uses and fire protection.

Installation of a High-Pressure Fire-Service System, by far the largest in existence, which has successfully withstood the severest tests and brought about a large reduction in premiums and effectually protected the congested districts of high values against general conflagration.

Preparation and submission of detailed reports emphasizing the need of continuing in all boroughs the work of waste prevention and detection of illegal use of water, initiated and so successfully carried on in Brooklyn, as long as appropriations were available, and the gathering of the preliminary data required to establish proper meter rates and to determine the economical limitations of a meter system for the various boroughs of Greater New York. In Manhattan and Richmond valuable results have already been obtained from the work done.

Recommendations based on the foregoing reports leading to the introduction by the Merchants Association of what is known as the "Stanley Act" and the passage by the Legislature of this act, which gives the City authority to purchase and install meters in such sections as may be deemed necessary to obtain data on the use and waste of water, metering, etc.

Full and detailed report to the Board of Estimate in compliance with the terms of the Stanley Act on the force to be organized and moneys required to continue on an adequate scale, house-to-house inspection, investigation of leakage through the mains, detection of illegal use of water, and the data above referred to in regard to the installation of meters. The necessary appropriations for this work were asked, but action is still pending.

Since the appointment of Mr. Henry S. Thompson on Jan. 1, 1910, as Commissioner of this Department, the progress made in its various branches has been rapid, owing to his efficient direction and the devotion of his entire time to the organization of all bureaus on a sound and business-like basis. Shortly after taking charge, he divided the work of the Department into the following bureaus:

Engineering: In charge of all work connected with the extension, collection, transportation and distribution of the water-supply.

Water Register: In charge of the determination and collection of water rates.

Auditing: In charge of accounts and supplies, it being later intended to have a separate Bureau of Supplies.

ENGINEERING.—During the two or three years preceding the appointment of Commissioner Thompson, the work of the Engineering Bureau had been gradually parceled out so that it was in charge of no less than six independent heads acting without concert or cooperation and reporting directly to the Commissioner, thus creating a condition of things readily imagined and needing therefore no comment. Commissioner Thompson at once directed that a plan of organization be prepared for the Engineering Bureau, and the plan shown in the attached diagram [not reproduced here—Ed.] was submitted to and approved by him in March, 1910.

Under this organization proper divisions were formed to effectually supervise the various parts of the work, each with a responsible division head reporting to the Chief Engineer as the central authority in the direction

of all work. The results accomplished by this organization may be briefly summarized as follows:

Standardization for all boroughs of design and specifications for pipe, special castings, valves, hydrants, etc., and also of methods for construction and operation.

Preparation of comprehensive plan of distribution for all boroughs, providing both for present and future requirements.

Preparation on a uniform basis of record plans of distribution system in all boroughs where they did not exist.

Increase in the amount of new construction and maintenance work done by the departmental forces.

Organization of Water Measurement and Water Waste Division to carry on a pitometer survey of the water mains in all Boroughs, especially along the water front, where the maximum waste is expected.

Reduction of payroll of approximately $200,000 per annum.

Elimination of unnecessary works projected in some of the boroughs for which funds had already been provided, amounting to about $1,000,000, authorization for the same being therefore canceled.

Continuation of the experimental work, started five years ago, to reduce the cost of fuel for the fifty pumping stations in our system, by the use of cheaper grades, which already has resulted in a yearly saving, based on previous conditions, of about $150,000.

Reduction in future cost of maintenance estimated at somewhat less than $200,000 per annum, due to elimination of unnecessary works and change in plans.

WATER REGISTER.—In the Water Register's Bureau, extensive reorganization and change in methods have been effected, the books now being kept in such a way that the exact condition of any account can be ascertained at any time, and the total amount of revenue received and due can be given at the end of each day's business. The Inspection Division of this Bureau has been thoroughly reorganized and the Inspectors placed in uniform. All meters are now read once a month. All large meters are to be frequently tested in place. As the value of the water used with small meters would not warrant frequent tests, the testing of these small meters will be made at economic intervals. A complete resurvey of all premises in all Boroughs is provided for, and the work is being carried on as rapidly as the force can be organized. It is planned that every building within the Greater New York supplied from the municipal water system will have been resurveyed within the next year or eighteen months. Modern meter-testing apparatus is being installed for all Boroughs, the testing of the meters being carried on by the Department force. Incidentally it may be well to add that the installation and testing of meters, and all work connected therewith, has been, in accordance with charter provisions, in charge of the Water Registers in the various boroughs and not under the Chief Engineer. The competence of the present Water Register in the Borough of Manhattan, Mr. Clair Foster, is certainly beyond question, and his appointment reflects much credit on the Commissioner who made it.

The efficiency of the work done in the Water Register's Bureau is illustrated by an increase in collections for the year 1910, as compared with 1909, for the Borough of Manhattan, amounting to about $1,590,000, which is approximately 27% of the total amount collected during the year 1909. The total increase in collections for all boroughs was $2,035,000.

AUDITING AND SUPPLIES.—Progress has also been made in regard to the purchase of supplies, which are now secured under a system insuring competition and carefully-drawn specifications which are being gradually standardized. The installation of a thorough cost-accounting and store-room system is under way, and will be completed as soon as practicable; experts having been employed on this work for some time.

The above brief outline of the work actually accomplished, and under way, all of which can be substantiated by investigation, should be ample refutation of any charge of lack of progress in the Department, and still more so of the charge of retrogression during the last few months.

As the wording of your article might create the impression that important work undertaken by Mr. Bemis had been discontinued since he left, it is proper to state that the only work initiated by Mr. Bemis which has been dropped is the repairing of meters and furnishing of new meters to consumers by the City. The reason for dropping this work was that the Commissioner has no authority, under our present laws, to carry on the work, because the City does not own the existing meters and cannot legally enforce collection of a bill rendered for repairing a meter already placed or installing a new one, unless the property owner refuses to repair a meter in use or to replace it by a new one. Should laws be hereafter enacted enabling the City to own and control meters, the installation and repairs of the same should and would be made by the Department, as is done at present with the other appurtenances of the system. Further improvements are still required and should and will no doubt be made, but owing to their magnitude and the needed favorable action thereupon of other municipal departments and officers, these improvements cannot be the work of a day.

One of the points specially mentioned in your editorial was the setting of curb cocks on services, which it was intimated had not been done prior to Mr. Bemis' connection with this Department. In the Borough of Brooklyn, for many years, these curb cocks have been set on all services, and since 1905, upon the recommendation of the writer, it was ordered that these curb cocks should also be set on all new services in the Boroughs of Manhattan and The Bronx, and this has been done. The question of setting them on existing services was also taken up, but it was found that the City had no legal right to order the property owner to do so at his own expense, as he owned the service, and it also appeared doubtful whether the City had the authority to incur the expense of setting these curb cocks.

As to the storage of a large number of curb cocks, with the necessary boxes, purchased by a former Chief Engineer, alluded to in your article: This material was purchased with the object of improving existing conditions, but it was found afterwards that the City had no legal authority to use this material as intended, so that the curb cocks and boxes are still in Department Yards and will probably have to be disposed of at a material loss unless a change in legislation is made.

The Department is to-day striving earnestly and successfully to carry out its work in accordance with the best modern practice, and the progress made is substantial and is increasing from day to day and month to month. With the cooperation of the Board of Estimate and Apportionment, hitherto uniformly secured by the present Commissioner, permanent improvements have already been made and will be continued which should silence the criticism based on the condition of former years but certainly not justified at present.

Very truly yours,

I. M. deVarona, Chief Engineer,

Department of Water Supply, Gas and Electricity.

13 Park Row, New York City, Feb. 7, 1911.

[We give space with pleasure to Mr. de Varona's summary of the progress which has been made in planning and in carrying out much-needed reforms in the Water Department of New York City. The frank and straightforward tone of his letter certainly deserves recognition and approval.

The business of an engineer engaged on construction work has been defined as making a dollar earn the most interest. The business of an engineer in charge of operation and maintenance is to make every dollar expended go as far as possible.

We have little doubt that a large part of the waste and inefficiency that has prevailed in the past in the New York Water Department has been because the engineers have not had a free hand. Their superiors have measured their ability by the number of places they could provide for political retainers rather than by their achievements in either technical or executive work. If Commissioner Thompson and his staff can cut out the political deadwood and substitute efficient and economical methods for those which have ruled in the past, they will deserve the gratitude of the taxpayers.—Ed.]

On the Question of Licensing Civil Engineers.

Sir: The long study on the licensing of engineers, pp. 115-117 of your issue of Jan. 26, 1911, may be answered in two words: More money. The State wants additional ways of taxation.

Your note on Brandeis, page 106, would stand up well in heavy type; it is too gentle.

New York City, Jan. 30, 1911. J. B.

Sir: Referring to your article in Engineering News of Jan. 26. Our State Legislature has the idea that it is necessary to license engineers in this State and I would appreciate it very much if you would send me any other articles on this subject which would be of use to me and to them on this subject. It would seem to me some arrangement could be made whereby the members of engineering societies, such as the American Societies of Mechanical Engineers and Civil Engineers could use their memberships in the society in the same sense as a State license, and that this matter could be put before the public in such a way as to exclude to a great extent the practice of so-called engineers.

Eugene Hunt.

Walla Walla, Wash., Feb. 1, 1911.

Sir: In reading last week's Engineering News, I noticed an article with reference to the licensing of Civil Engineers. There are incompetent men doing great engineering jobs, and thus injuring the profession, and for that reason there should be some check put on it.

As far as I know, there is nothing being done in this state as yet, to pass a law to license civil engineers. They have an ordinance requiring operators of engines and boilers to have a license, which is something I am fortunate to have, but as to whether or not they will pass a law to require a license of a civil engineer, I am unable to say, but I will say that something will have to be done to cut out a certain class of men from practicing civil engineering on account of incompetency.

Arthur W. Clemo.

300 Abbott St., Detroit, Mich., Feb. 2, 1911.

Sir: I have read with much interest the articles which have appeared in Engineering News concerning the licensing of engineers. I appreciate fully everything that has been said against such legislation, but I am still doubtful whether it would not be beneficial to the majority of engineers and to the people in general.

If men who employ engineers and surveyors would exercise the proper judgment and employ only competent men, the law would of course be useless. However, by observation we find that a great many employers do not use the least bit of judgment or common sense in employing engineers. A man gets a position as Chief Engineer of a coal company simply because he is a son-in-law of the President of the company. The Chief Engineer could not get a license either by the experience that he has had or by any chance that he might have at passing an examination. If this is not an injustice to the profession what can it be called?

In another case a company wishes to build a railroad into its timber and coal lands. The engineer is entitled to his job because he has been faithful as a land agent and squatter for the company. He cannot adjust a transit or a wye level and does not understand the tables usually found in the backs of the field books.

In still another case the county road engineer has been a foreman on railway construction. If he needs to have surveying done he hires a surveyor at $5 per day to do his work for him. The county officials allow this extra expense, which is not just to the people. Again I could name a dozen county surveyors who got their positions not because they were qualified, but because their names appeared in the right place on the election ballot. I know of many fortunes that have been wasted in courts on account of the work of incompetent surveyors. Our courts are crowded with just such cases.

How can we correct these evils and properly protect our profession as well as the citizens without a law restricting the practice of engineering and surveying to competent persons? It seems to me that the majority will be benefited.

Yours very truly,

H. L. Handley.

Spruce, W. Va., Feb. 6, 1911.

[In our editorial of Jan. 26, we pointed out that benefits can result by taking *specific branches of engineering work* such as surveying, and requiring a certain grade of education and competence for those who do such work. No law, however, can prevent the practise of favoritism or nepotism. If the President of a company cannot make his son-in-law a Chief Engineer, he can make him a General Manager and the engineers under him will be no better off.—Ed.]

Sir: I have read with interest the article in your issue of Jan. 26, referring to the action taken by the Am. Soc. C. E. on what is called the licensing of engineers. I think there is a real need of action of some kind. The possible objects of action might be, in order of their importance: (1) to safeguard the public; (2) to obtain more dignity for the profession; (3) to secure better compensation for engineers. The first object may be dismissed at once, for I think that in the selection of an engineer for every work of such magnitude or character as to involve the public welfare the requirements of any probable license legislation are already surpassed in all cases, with few if any exceptions.

Increasing the dignity of the profession is, I think, the sum total of the need of legislation. The act should make it necessary for all persons engaged in engineering work, from stake driver to chief engineer, to be graduates of reputable technical colleges. Beyond such a requirement, engineers ought to look out for themselves.

I have seen many engineering organizations where most of the men have had nothing more than a common-school education, and know nothing of mathematics beyond the solution of a plane triangle, yet work along with college graduates, get as high salaries, and think themselves as much engineers as the technical men. It is true there have been and are now many good engineers not college men, but I think enough technically trained men could be found in the future to take the places of these non-technical men who might develop into good engineers. This may be a narrow view, but I do not know why engineers should require less or should ask the law to be less strict in the qualifications of its members than the other professions do, and the right of the other professions is never questioned. Besides, if anything is to be done to put the profession on a better footing, somebody's feelings will have to be hurt.

As for the comparatively small remuneration engineers get, I think it is due partly to the fact that there are so many non-technical men engaged in the work, who are willing to take what they can get, thereby pulling the technical men down to the same level, and partly because engineers are so wrapped up in facts and figures they have lost all sense of business acumen. It is really a shame that men who have studied hard and have spent from $2,000 up for an education, should have to work for scarcely more than clerks' compensation. I have no sympathy with unions, at least in the commonly accepted

sense, applied to engineers, but I do think if they could see that only engineers can do engineers' work and would insist as a body on better salaries they would get them, whether capitalists and corporations wanted to grant them or not.

The selection of the word "licensing" is unfortunate for the dignity of the profession. The state, county, city, or whatever, licenses enginemen, pedlers, auctioneers, saloon keepers and dogs, and we want to be licensed, too. Well, if we cannot respect ourselves what the devil's the use asking anyone else to do so?

Pittsburgh M. Am. Soc. C. E.

Pittsburg, Pa., Jan. 30, 1911.

[The State legislates (or should legislate) to protect the interests of the public. It requires physicians to have a certain modicum of education in order to protect the public from ignorant quacks. It requires lawyers to have a certain modicum of legal knowledge because every lawyer is a part of the machinery of justice and has legal obligations to the public as well as to his client. This legislation is not enacted to lessen the competition among doctors and lawyers and make it easier for them to earn a living. As a matter of fact it has not prevented both those professions from becoming far more overcrowded than the engineering profession.

Our correspondent thinks legislation ought to be passed to "increase the dignity of the profession"; but does it seem particularly dignified for members of the engineering profession to appeal for legislation to aid its members? How does that differ from the action of the labor unions, who frequently seek for legislation which will restrict work in certain trades and occupations to those who hold official licenses?

In so far as the members of the professions of Law and Medicine are on a better footing as regards financial return than engineers, we believe it is due to their own action in the adoption and enforcement of ethical codes rather than to any aid they have received from legislation.

As of interest in this connection, we print below resolutions adopted at a meeting of the Boston Society of Civil Engineers on Jan. 25.—Ed.]

WHEREAS, laws requiring the licensing of engineers have been suggested in the legislature of several states, and

WHEREAS, the membership of the Boston Society of Civil Engineers is scattered over practically the whole United States and the practice of its members is still more widely diversified, and

WHEREAS, there are societies of engineers in the United States, membership in which can only be secured after rigid examination of the fitness of applicants to practice as engineers, and

WHEREAS, the public has ample protection if they will employ only those who have thus demonstrated their ability; be it

RESOLVED, that the Boston Society of Civil Engineers does not deem it necessary or desirable that engineers should be licensed in any state.

What is the Best Pipe For Laying in Salt Ground?

Sir: Being an old reader of your valuable and well-known paper, I take the liberty of asking for the following information: (1) Which is the best 5-in. piping for carrying water across 12 kilometers of salt ground and passing through a short distance of 800 meters of sea water? (2) Can cement be used as a preventive against corrosion of the pipes, caused by the salt water? (3) What is the best method of preserving the piping in the salt water so as to enable one to examine and repair same easily? Yours truly,

Oscar Ribeiro.

Rua da Boa Vista, 37, Sao Paulo, Brazil, Jan. 14, 1911.

[The problem our correspondent presents is not one to which a very satisfactory solution can be given. The choice would apparently lie between ordinary cast-iron pipe and wooden pipe. On account of the long distance which the material would have to be transported, the wooden pipe would probably have a large advantage in first cost. The life of the wooden pipe would depend, of course, upon the resistance to corrosion of its exterior steel bands. By making these of metal resistant to corrosion, either the new ingot iron or bronze, the pipe might have a much longer life than cast-iron. It might be practicable, also, to surround either the cast-iron or the wooden pipe with concrete and make a permanent job. If the 12 kilometers of salt ground is level salt marsh, as is probably the case, the delivery of water through pipe of so small a diameter will be comparatively small unless it is feasible to use a high pressure at the entering end of the main. For the pipe to be laid under water, we know of nothing better than ordinary cast-iron pipe, with flexible joints at intervals.

If any of our readers can suggest a better solution, we shall be pleased to hear from them.—Ed.]

Notes and Queries.

The inventor of the adjustable triangle described in our issue of Feb. 9, p. 167, is Robert A. Saas, 7 East 42d St., New York City. His name and address were given incorrectly in the issue referred to.

City Transportation Problems; A Report by Bion J. Arnold on the Pittsburg Station.

(Concluded from our issue of Feb. 9, 1911, p. 178.)

A Comparison of the Larger American Cities with the Pittsburg District.

Each American city has a business "center" which has developed about the "origin" of the city as shown in Fig. 2. As the first contact with the outside world was by means of water transportation each city developed first along the water front, and afterwards as means of land transportation were developed, the city spread out, its particular shape being the result of the topography of the district. In cities where the electric suburbans are operated directly by the city-traction system as in Pittsburg, Milwaukee and Detroit, these lines have been added to the maps. Independent lines are not shown.

The transportation problem is largely one of transporting the workers from and to their homes during the morning and evening rush. If the traction equipment is sufficient for adequate service during these peaks, it will be ample for all other times. The problem becomes more and more difficult as the radius of service from the business center increases. *Pittsburg is unique in that its "business center" is not at one side of the city.*

The curves of Fig. 3 record the population of the first 15 cities of the United States for successive decades, as compared with Pittsburg, Allegheny County and the Pittsburg Traction District. With the exception of the District population, the curves are based on the United States Census returns and include successive annexations in the various cities. This is partly responsible for some of the irregularities in the curves, as for example in the case of Chicago, which annexed a large territory in 1889, thus causing an abrupt rise in the population curve.

The population of the Pittsburg Traction District is now approximately one million people, which is also about the population of Allegheny County—but on account of the extensions of the trolley system into new territory, the population served by the traction system has been increasing faster than the population of the county. Judging therefore from past experience, it is reasonable to estimate that the Traction District will double in population within about 30 years' time, while the county will increase from 1,000,000 to 2,000,000 population in about 40 years, or by 1950.

A comparison of the results obtained by the different surface traction systems in all of the largest American cities is now desirable and illuminating—but conclusions from such a comparison made at this time should be approached with caution. Conditions surrounding different cases vary so that practice is not the same throughout the country; a uniform system of accounting has not yet been universally adopted, exact information is not always available, and a policy of interchanging information, which no doubt will eventually be found desirable, has not as yet proven generally acceptable.

The comparisons made have been based on the latest figures that it has been possible to obtain from official sources.

In studying any transportation system, the fundamental items of critical interest are Earnings; Service; Operating Ratio; Deductions from Income, such as Taxes and Depreciation; and Profit to the Operating Company. Other data are also useful in a detailed study, such as Trackage, Equipment, Fares, Transfers, Reserve Funds. Both actual figures and ratios have been used so that systems can be compared on the unit basis, irrespective of size.

In making the graphical comparisons of Fig. 4 the income in each city is taken at 100% and the relative distribution (in per cent. of this income) for operating expenses, depreciation, taxes, fixed charges and surplus is indicated along the irregular lines. When there is a deficit, it is shown above the 100% line, being excess expenditure over income. The cities are arranged in the order of their approach to a moderate return to the operating companies. This return is indicated by the upper shaded portion showing demands upon income for fixed charges, dividends and surplus. Thus Chicago ranks first—24%, Pittsburg sixth—32.6%. The lower shaded portion represents what part of income is absorbed in operating expenses.

The company return (including fixed charges, dividends and surplus, or deficit), and the service rendered, as indicated by operating expenses, are of the greatest importance. The first represents the total amount retained out of income for interest and for return to the operating company or its subsidiaries; the second, what part of income is put back into the service. The comparison shows (a) that, in service rendered, three other cities, Chicago, Boston and Detroit get back a larger percentage of the fare than Pittsburg; (b) that Pittsburg does not appropriate out of earnings, as much for renewals due to depreciation (*) as some of the other cities; (c) that the taxes paid by the railway system in the Pittsburg District are at present comparatively small; (d) that only two cities incurred a "deficit" last year, Pittsburg and Philadelphia, several, on the other hand, clearing a substantial surplus. It is instructive to note, that in Chicago and Boston, the return to the companies in the form of "fixed charges, dividends and surplus" is relatively smaller than in any other cities. In Chicago, both investment and return are determined in the new traction ordinances, while in Boston the capitalization is regulated by the State Railroad Commission. The results are that the riders in Chicago obtain their transportation by returning to the company about 24% of the fares paid, while in Boston they return about 26%. In Pittsburg, however, the "fixed charges" amounted to 45.8%, but on account of a 13.2% "deficit" the actual return to the company was 32.6%. If this deficit is to be collected out of future earnings, then Pittsburg's patrons will pay a higher relative return to the company for their transportation than in any of the other American cities shown with the exception of Washington.

Comparisons of traction results in various cities, if made intelligently and with proper reservation, may serve to make more definite the general impressions of other observations.

In these comparisons, both total quantities and ratios have been used, the one conveying an idea of the size or extent of the traction operations, the other, reducing the data to the same basis irrespective of size. Thus these ratios may be regarded as measures or indices of density, service, crowding, activity in the use of equipment, etc.

Fig. 5 recapitulates at a glance the more important relations of the tables prepared, exclusive of the financial results shown by Fig. 4. The four lower groups of ordinates record total quantities; the remaining groups above show ratios between these quantities. Note that all the car mile ratios are plotted from the same base line, likewise the ratios per mile of track. The figures opposite each city record its respective rank.

In conclusion these comparative results may be summarized in the following order: Extent of System, Service Rendered leading up to the fundamental—Financial return.

In extent, the Pittsburg system may be said to be relatively overexpanded as compared to larger or more densely settled cities. This necessarily reflects in a less density of patronage, and lower earning capacity per mile of road, indicating plenty of opportunity for cultivation of traffic along the lines already constructed.

Similarly, the density and frequency of service is adversely affected by this patronage being spread out over a large area. However, decided efforts have been made to maintain income per car mile at a high point, which can hardly be done under such conditions without economizing service. Many other cities excel Pittsburg in activity of equipment, i. e., annual mileage per car. Conversely this is reflected in the relatively high unit earnings per car mile and per car.

Transfer arrangements in Pittsburg are extremely curtailed resulting in a lower total passenger traffic than would be expected, and also a fictitiously low factor of crowding—passengers per car mile. However, the maximum fare is maintained with relatively few concessions below five cents.

In final return to the company, Pittsburg is evidently attempting the impossible under present conditions of traffic, service and income owing to the excessive burden of fixed charges. Operating ratios for the important cities average out about the same as Pittsburg, but including taxes and depreciation, Pittsburg is somewhat below the average. However, if the deficit incurred be disregarded, then the Pittsburg system would appear to be in a fairly favorable position.

Analysis of the Present Situation.

Both the city and the company are waiting for the other to act. The city desires to know when all the cars recommended by the Railroad Commission and promised by the Railways Company are to be delivered, where they are to be run and when the tracks and paving will be repaired. The Company has submitted a rerouting plan and a list of additional streets over which it desires

*It should be explained in connection with Chicago results that the low depreciation charge is due to the rehabilitation work in progress. Later, an annual charge of not less than 8% of the gross receipts for renewals is provided for by ordinance in addition to not less than 6% of gross receipts for ordinary maintenance. Baltimore's contingent reserve is regarded as depreciation, and Chicago City's share in profits as additional taxes. Brooklyn and Philadelphia do not disclose their methods of treating depreciation.

franchises, but makes no definite answer as to the cars. There is every reason why more cars should be furnished by the Company and plenty of evidence as to the desirability of rehabilitating the tracks. There are also good reasons why the City should grant permission for new connections so as to permit the improved routing of cars. But why is not something being done?

WHY THE COMPANY DOES NOT ACT.—The Company seems to be uncertain as to its future policy because: (a) The system has been overexpanded and parts of it already rebuilt several times out of capital account; (b) The organization agreements resulted in heavy fixed charges and were made apparently without definite provision for renewals due to obsolescence and inadequacy; (c) several business depressions in the District have resulted in an unsettled confidence in the future; (d) a constantly increasing deficit makes it difficult to interest new capital for necessary improvements; (e) operating expenses have increased out of proportion to income on account of the increased cost of labor and material and also on account of past curtailment of maintenance; (f) the attitude of the city during the past administration was antagonistic and the present administration has kept the company in a defensive position.

WHY THE CITY DOES NOT ACT.—The City cannot be expected to "turn all the rest of its streets over to the company" because (a) provisions in past franchises seem not to have been lived up to by the Railways Company; (b) the power of the City to regulate service and fares has not been established; (c) the City's control of the streets as to the repair of paving along tracks is in doubt; (d) the power of the City to specify transfers or routes on which the cars are to run is not certain; (e) there is no assurance that the present company has the financial ability to take care of constantly growing demands; (f) the surrender of additional streets in the downtown district would eliminate the possibility of competition.

The question of extensions apparently opens up again the relation between the city and the company. If the city grants assure the company protection from competition, then it would appear that the natural result must be some form of public control which would insure adequate service, and at the same time result in a fair return on the actual investment.

WHY THE COMPANY AND CITY SHOULD ACT TOGETHER.—There is every reason to believe that the old system of granting franchises without retaining the power of public control or right to purchase does not produce a satisfactory transportation system.

The exploitation of the system as an "investment" creates a growing feeling of suspicion and unrest on the part of the public that it is not getting all of the service it should, and this dissatisfaction finds expression in suits and regulating ordinances.

The operating company finds that the net returns after paying operating expenses for the service which public pressure demands, is not sufficient to justify its capitalization.

It will thus be seen that the expectations of neither party are fulfilled under the present arrangement, and both should therefore be interested in devising and agreeing upon a more satisfactory and permanent plan.

BASIS FOR A PERMANENT SETTLEMENT.—Drawing upon the Chicago and Cleveland settlements for experience, it is apparent that a continuous working agreement should be based upon at least the following fundamental considerations.

Fair Return on Investment should be assured on the basis of an agreed rate of return on the actual present value of the property (cost to reproduce minus depreciation); this value to be determined by an appraisal of the present physical property to which should be added an agreed allowance for development expenses.

A fair return should also be allowed upon all money spent upon the property to rehabilitate it and put it in first-class operating condition so as to give adequate service, as well as on all moneys spent on extensions and improvements.

Rehabilitation. — Property to be rehabilitated and maintained up to an average operating condition equal to at least 70% of its cost to reproduce new, all future maintenance to be paid for out of operating expenses, and renewals to be made out of the earnings of the property.

Improvements and Extensions. — The system should have the benefit of the latest improvements in the art and its equipment should be kept up to date. To take care of constantly increasing demands of the city's growth new capital should be available for extensions.

Adequate Service.—To be measured in definite terms, preferably in a percentage of the income, so that the greater the yearly income the better will be the service.

Routing. — The re-routing should not only eliminate useless car-miles, but should provide a reasonable number of through routes so as to make it possible to pass through the center of the city to the further limits of the "through zone" without transferring or paying an additional fare.

Transfers should be provided so that a continuous single ride can be secured in one general direction with at least one free transfer.

Publicity and Control.—All of the technical details, expenditures of money on property, methods of operation, standardization of accounts and general auditing of books should be under the supervision of some Board (upon which both the city and the company might be represented) empowered with authority to initiate reasonable improvements, control operation and cause its acts to be enforced. The records of this body should be open to the public.

Right to Purchase.—The new agreement should be in the form of an indeterminate permit or franchise, sometimes called a "tenure during good behavior." Such a grant can be terminated by the city at any time upon the payment of a fair compensation for the value of the property, exclusive of franchise values.

It would be unreasonable to expect such a radical change to be accomplished at once. All permanent progress takes time. The city will hardly be ready for such a settlement until it realizes that transportation must be handled as a district problem, and therefore some form of district organization must be provided. The company, presumably, would not be prepared to surrender its perpetual franchise rights for the privilege of an indeterminate grant unless the affairs of the combined system reached an acute stage due to the continued accumulation of deficit and depreciation obligations. In the meantime, something should be done.

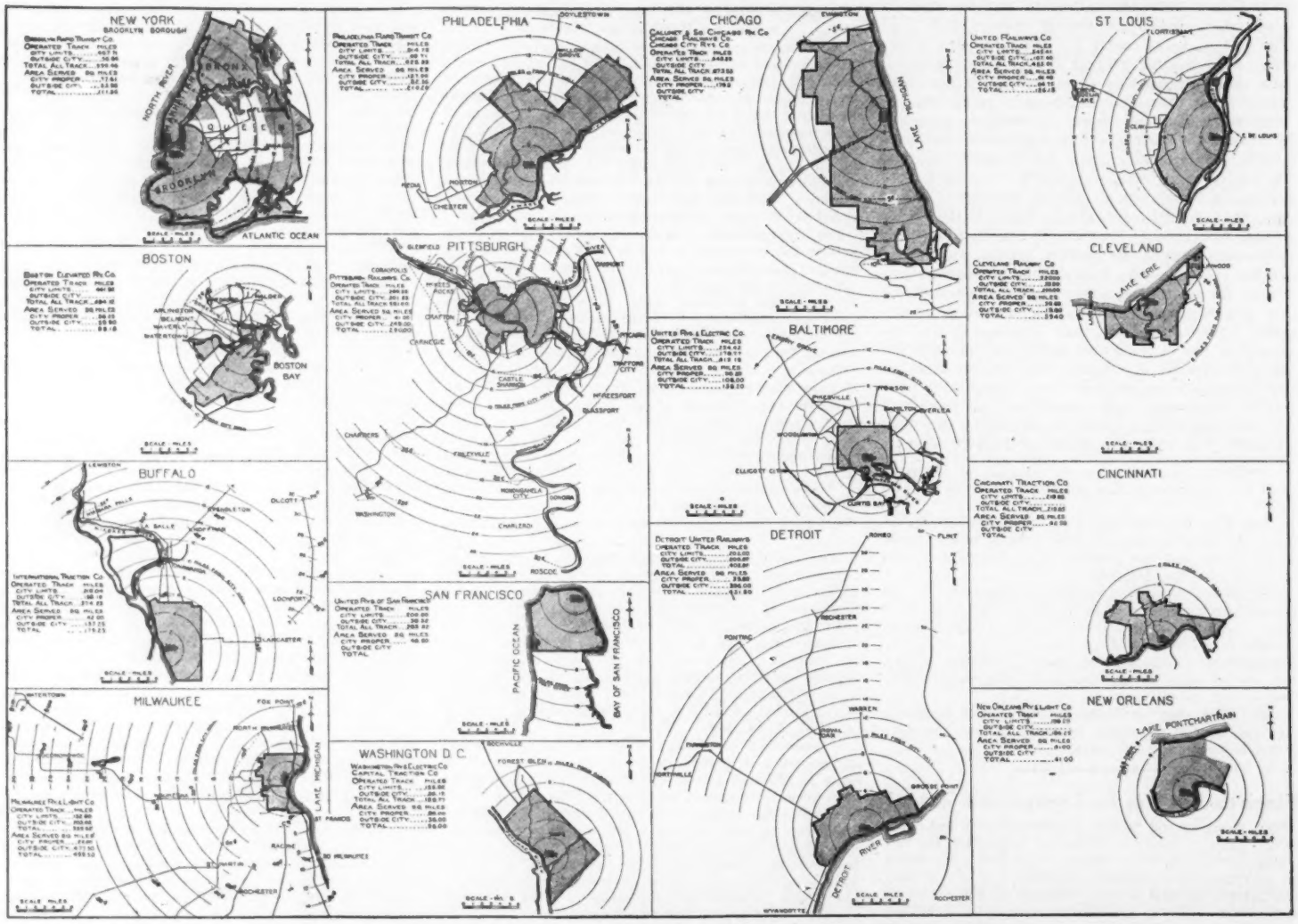


FIG. 2. A COMPARISON OF SIZE AND SHAPE OF THE LARGER AMERICAN CITIES.

I. Immediate Surface Railway Improvements.*

Whatever the outcome of the reorganization and regulation of the present surface system, there should be no delay in arranging for proper maintenance of the cars and tracks, for additional larger cars, for improved and

[*The preliminary report, in Eng. News, Aug. 4, 1910, should also be read for a discussion of the faults of the Pittsburg system.—Ed.]

maintained schedules and for proper heating, ventilation and lighting of the cars. The city and the company should give their unremitting efforts towards widening the Smithfield St. bridge and the elimination of dangerous grade crossings, for there are no good reasons why these enterprises should remain inactive pending the development of future policies. The question of more cars, better tracks, improved schedules and the widening of Smithfield St. bridge should be followed up with vigor, and although the necessity may arise for the city and the company to defend their various rights in the courts, this legal attitude should not interfere with the establishing of a policy of cooperation and publicity upon which future progress must depend for the mutual advantage of all concerned. Actual facts should hurt no one and what is wanted is more of them so that the present atmosphere of suspicion can be removed by an era of actual knowledge.

II. Future Surface Railway Improvements.

The future growth and prosperity of the Pittsburg district depends in a large measure upon the development of the surface trolley system and this report has been confined largely to a discussion of the elements of this part of the traction problem and its solution. The future of this surface system depends upon the efficiency of the plans for rehabilitation, improvements, renewals and adequate service and whether or not such plans are carried out consistently.

REHABILITATION.—Many miles of the tracks of the system are in a bad condition and the paving is so dilapidated in frequent places as to be a serious impediment to vehicle traffic. The condition of Pittsburg's streets along the car track lines is a serious reflection on the City, and one which neither the City nor the Company can afford to tolerate.

Some of the cars listed by the Company are rapidly becoming worn out and obsolete in style, while some of the power plant equipment still used is so inefficient as compared to more modern types that the continued use of this type of power station cannot be justified. Car houses and repair shop facilities are inadequate on some divisions of the system, and wooden trestles and bridges must soon be replaced by more permanent structures. Overhead construction needs replacing and feeder wire should be put in conduit in the underground district. Millions of dollars could be spent to good advantage at once in the general rehabilitation of the property.

IMPROVEMENTS AND EXTENSIONS.—The advances made in the art and the constantly growing demands of increasing business indicate that new capital must be continuously available for betterments and extensions. Experience in Pittsburg and in other American cities demonstrates that when the population is increased by 50%, that the earnings from transportation more than double; that is, the demand for transportation increases much more rapidly than the growth in population. This demand can be cultivated by making it easy to ride, in the same way that the telephone business has been built up, by making it convenient to use telephones. But this conception means a constant series of improvements. In the Pittsburg district, an expenditure of at least $2,500,000 new money for betterments would be justified each year, and if this new money is not provided the city and the district will be handicapped in their growth and prosperity as compared with other cities more fortunate in their traction arrangements.

Decided improvement should be made in the form of track construction. A substantial sub-base should be provided, and this should be drained when conditions indicate danger from sub-surface water. The paving should be laid so as to present a practically waterproof surface, and should have frequent sewer connections for the removal of rain and excess sprinkler water.

Certain extensions and changes in the tracks must naturally be the result of a thorough re-routing of the system. Car houses, in some cases, should be relocated and improved repair facilities must be provided for the larger steel-constructed cars, which should eventually replace the small single-track wooden equipment now used on many of the lines.

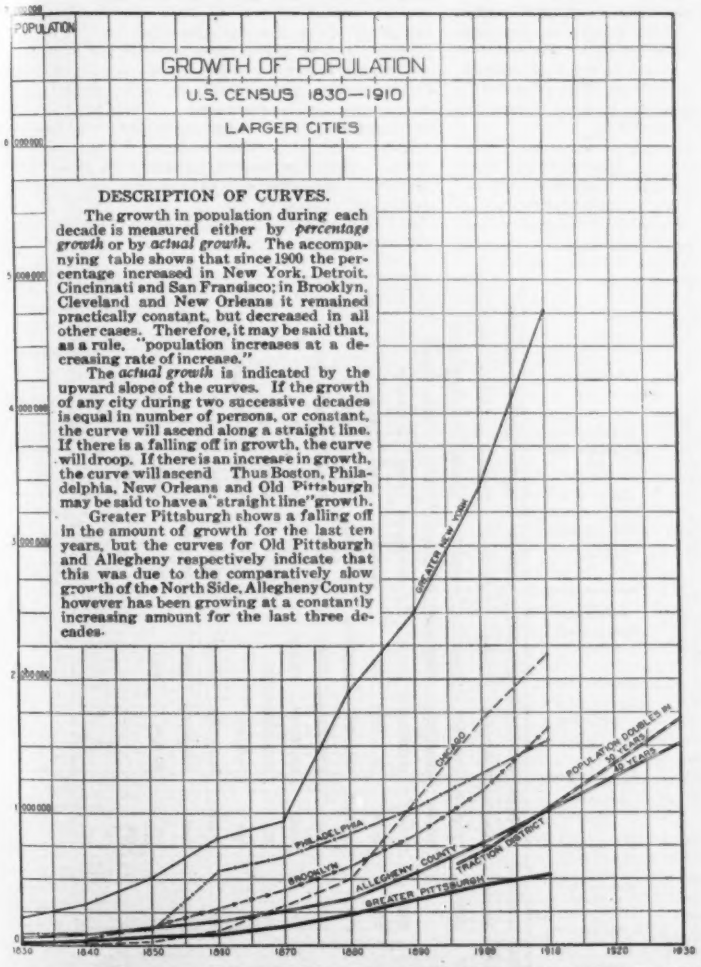
Experience is showing that the best way to avoid electrolysis is by means of an adequate return circuit and electrically-connected rail joints of a current-carrying capacity fully equal to the rail itself.

A long catalog of defects which should be remedied, and of improvements in the system which should be effected, could be prepared, but until the financial part of the program has been determined upon, a detailed list of requirements will be of little use.

DEPRECIATION AND RENEWALS.—Depreciation, like interest, works every hour of every day, and with a street-railway property, at a rate on the whole value of the property of about half the present interest rate. In making the combinations which resulted in the system now operated by the Pittsburg Railways Co. abundant attention was given to the question of a return on the investment in the shape of interest and guaranteed dividends, but apparently no provision was made for taking care of that equally important item—depreciation. The result is a property which is now ready for renewal in many of its parts, and neither the lessors nor lessees seem to be prepared to assume the burden of replacement cost. But whatever the method devised for taking care of cumulative or past depreciation, there should be adequate provisions in the future program for handling the property to take care of current and future obsolescence and the other forms of deterioration which cannot be offset by ordinary maintenance and regular upkeep.

RE-ROUTING AND IMPROVED SCHEDULES.—The question of transfers, through routes, downtown loops, terminal facilities, location of car houses, use of trailers, and the equitable distribution of cars over the various divisions to take care of the constantly shifting demands for service, are all important questions which need extensive study and can be best settled in a spirit of cooperation between the city and the company. Preceding final decision on these questions, however, there should be a definite settlement of the question of what proportion of the income from passenger earnings is to be returned to the system in the form of operating expenses to provide service. The determination of this question would allow the settlement of the other problems on a reasonable basis which could be maintained even if the original conditions are altered.

ADEQUATE SERVICE.—The requirement of adequate service has been mentioned last, but in reality it is first in importance. Above all else the whole transportation arrangement should be devised to provide "adequate service," for the growth of the community depends upon convenient inter-communication between all its parts. Just what constitutes adequate service is not easy to define. The actual service supplied is necessarily affected by the amount of the investment, the rate of return on this investment, and the cost of operation including renewals. If all these factors are accurately known, then adequate service might be defined in terms of the income or fare, that is, a given fare would mean a corresponding service; raise this rate of fare and the service could be improved. But to reach a conclusion as to adequate service by this method, means first—an official appraisal as to the value of the property, both of its "cost to reproduce" and the depreciated or "present value," second—an official decision as to the rate of return to be allowed on this value as well as upon all new capital required for rehabilitating the property, and for extensions and for betterments, and third—some system of public record which will make it possible for an authorized check to


POPULATION
GROWTH OF POPULATION
U.S. CENSUS 1830—1910
LARGER CITIES
DESCRIPTION OF CURVES.
The growth in population during each decade is measured either by *percentage growth* or by *actual growth*. The accompanying table shows that since 1900 the percentage increased in New York, Detroit, Cincinnati and San Francisco; in Brooklyn, Cleveland and New Orleans it remained practically constant, but decreased in all other cases. Therefore, it may be said that, as a rule, "population increases at a decreasing rate of increase."
The *actual growth* is indicated by the upward slope of the curves. If the growth of any city during two successive decades is equal in number of persons, or constant, the curve will ascend along a straight line. If there is a falling off in growth, the curve will droop. If there is an increase in growth, the curve will ascend. Thus Boston, Philadelphia, New Orleans and Old Pittsburgh may be said to have a "straight line" growth.
Greater Pittsburgh shows a falling off in the amount of growth for the last ten years, but the curves for Old Pittsburgh and Allegheny respectively indicate that this was due to the comparatively slow growth of the North Side. Allegheny County however has been growing at a constantly increasing amount for the last three decades.
GREATER NEW YORK
CHICAGO
PHILADELPHIA
BROOKLYN
ALLEGHENY COUNTY
TRACTION DISTRICT
GREATER PITTSBURGH
POPULATION DOUBLES IN 30 YEARS
POPULATION DOUBLES IN 40 YEARS
1830 1840 1850 1860 1870 1880 1890 1900 1910 1920 1930

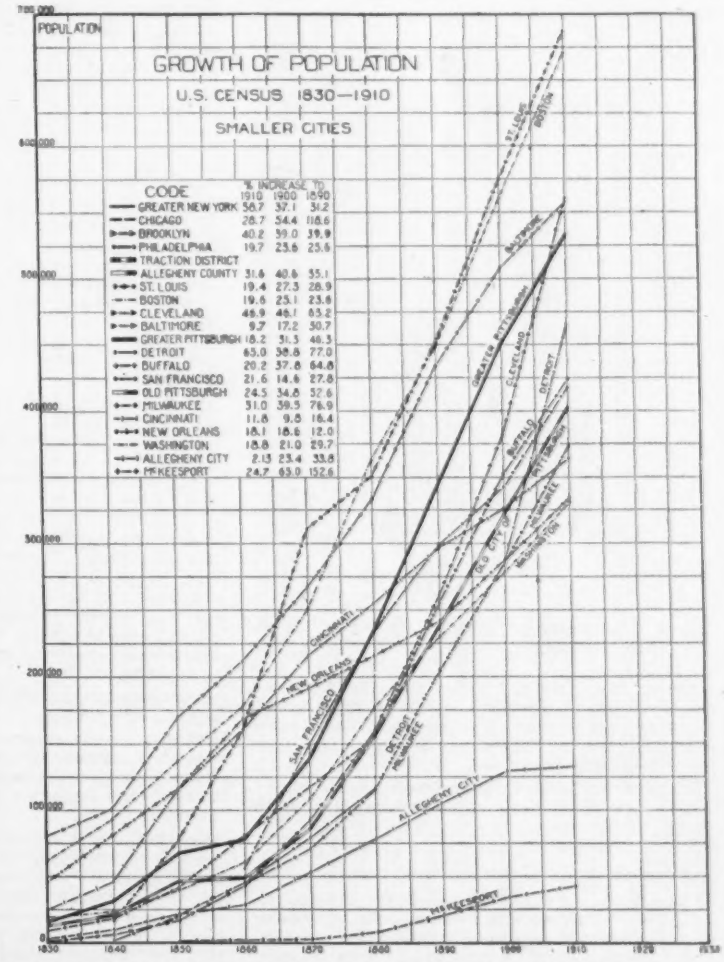

POPULATION
GROWTH OF POPULATION
U.S. CENSUS 1830—1910
SMALLER CITIES
CODE
% INCREASE TO
1910 1900 1890
GREATER NEW YORK 56.7 37.1 34.2
CHICAGO 26.7 54.4 116.6
BROOKLYN 40.2 39.0 39.9
PHILADELPHIA 19.7 23.6 25.6
TRACTION DISTRICT
ALLEGHENY COUNTY 31.6 40.6 35.1
ST. LOUIS 19.4 27.3 28.9
BOSTON 19.6 25.1 23.8
CLEVELAND 45.9 46.1 83.2
BALTIMORE 9.7 17.2 30.7
GREATER PITTSBURGH 18.2 31.3 46.3
DETROIT 65.0 38.8 77.0
BUFFALO 20.2 37.8 64.8
SAN FRANCISCO 21.6 14.6 27.8
OLD PITTSBURGH 24.5 34.8 52.6
MILWAUKEE 31.0 39.5 76.9
CINCINNATI 11.8 9.5 16.4
NEW ORLEANS 18.1 18.6 12.0
WASHINGTON 18.8 21.0 29.7
ALLEGHENY CITY 2.13 23.4 33.8
McKEESPORT 24.7 63.0 152.6
1830 1840 1850 1860 1870 1880 1890 1900 1910 1920 1930

FIG. 3. A COMPARISON OF POPULATION GROWTH IN SEVERAL AMERICAN CITIES AND IN THE PITTSBURG DISTRICT.

be made upon the cost of the property, the service supplied and the cost of operation from time to time. Such an arrangement has been the result of the "settlement" in Chicago and in Cleveland, and a similar state of affairs exists in Boston, where the State Railroad Commission has supervision over the operation of the railways. In Pittsburg, however, where no system of direct public supervision exists, the only answer that may be given at present to the questions "how much service can the Pittsburg Railways Co. afford to give under the present conditions?" is to compare the results of operation in Pittsburg with the results for those cities where some form of regulation exists. Such a comparison shows the relative proportion of income that is returned to the riders in the form of operating expenses or the equivalent of service as follows:

OPERATING EXPENSES IN PER CENT. OF INCOME.*

	Operating expenses not including taxes or depreciation.
Boston	66.76%
Chicago	63.20%
Pittsburg	59.92%

According to these figures, the riders in Pittsburg are getting back 60% of their nickel, or three cents out of every five in the form of service, while the Chicago

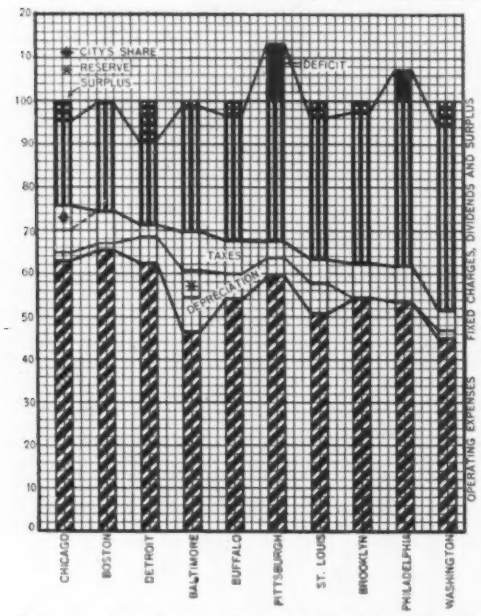


Fig. 4. Comparative Financial Results of Street-Railway Systems in Ten American Cities.

rider gets 63%, which is 5% more than Pittsburg's rate, and the patrons of the Boston system get 66%, which is 11% better than in Pittsburg. Looking at it from another standpoint, that of the relative returns to the company, the record is as follows:

COMPANY'S SHARE IN PER CENT. OF INCOME.*

	Fixed charges, dividends and surplus.
Boston	23.82%
Chicago	23.92%
Pittsburg	32.63%
Deficit	13.21%
	45.84%

These figures show that in Boston and Chicago, the properties are financed with a return on the investment equal in amount to an average of about 23% of the income. The demands of the financial plan of the Pittsburg system are that 45.84% of the income be taken for "fixed charges," although the actual amount available out of last year's earnings was about 32.6%, leaving a "deficit" of 13.21%. It will thus be seen that the "fixed charge" agreements of the Pittsburg system are a serious handicap in securing adequate service in the Pittsburg district.

FINANCIAL REQUIREMENTS.—The financial requirements of the surface system which are of the first importance may be recapitulated as follows:

1st—To procure sufficient funds for rehabilitation in order to offset past depreciation. This rehabilitation must be accomplished without increasing the amount of the present capital.

2nd—To provide an adequate renewal fund for current and future depreciation out of earnings.

3rd—To secure and protect new capital for present and for future betterments and extensions. This capital should be forthcoming from time to time to provide for constantly growing transportation needs and should be available somewhat in advance of actual demands for increased service.

The above financial requirements for a successful transportation system are not theoretical, as the financial necessities of the Pittsburg system are not different from those of other electric-railway systems where the above requirements and arrangements have been found advisable and practicable.

In Chicago, the solution has been worked out to meet the above requirements, but in doing so, a complete financial reorganization of the surface traction companies was necessary. An appraisal was made, establishing the actual depreciated value of the property, and ordinances which were passed nearly four years ago provide that (a) 70% of the passenger earnings shall be set aside during each of the first three years (the agreed period of rehabilitation) for furnishing service, paying taxes and taking care of maintenance and depreciation, (b) from the remaining net earnings, an amount is set aside to pay interest at the rate of 5% on the agreed appraised value of the property as well as upon all amounts spent for rehabilitation, betterments and extensions, all as passed upon by a Board of Supervising Engineers, and (c) a division of the remaining net earnings is made on the basis of 55% to the city and 45% to the company. This 55% is reserved by the city in a special fund, which is to be used exclusively for future traction developments.

The Chicago ordinances therefore fully comply with the above financial requirements, and the result of the operation under the reorganized arrangement is better service with a rehabilitated and improved system, and at the same time a fair return to the railway companies on their actual investment. During the past three and one-half years about $55,000,000 has been spent in rehabilitation and betterments of the surface railway system in Chicago, and the City's share of the earnings during this time has amounted to about $5,000,000.

In New York the efforts to establish the surface traction system on a substantial basis has resulted in receiverships for the more important companies, and the properties are now being largely rehabilitated out of earnings at the expense of interest and dividend obligations, but the questions of the protection of future capital and the depreciation fund for renewals are still to be determined. However, the orders of the Public Service Commission place adequate service ahead of all other requirements.

In Cleveland the new traction ordinances involved a valuation of the surface railways and a 6% return on this valuation, and an effort is being made to operate for a fare lower than 5 cts. The outcome, however, is still in doubt. Service, in Cleveland, is said to be still unsatisfactory, extensions have not been definitely provided for and requirements for depreciation are apparently still to be determined.

DIFFICULTIES IN PITTSBURG.—In Pittsburg, the difficulties to be overcome before a logical, financial program can be complied with are many, including the following:

(A) *The Leases.*—A large number of the underlying properties were brought into the present traction system at a time when the earnings were increasing at a remarkable rate, and at the same time the expenses of operation were lower than at present, or perhaps had been reduced purposely to make a good showing. In addition, the present holders of the property were very desirous of securing monopoly control of the traction situation. The result was that the guaranteed rentals on a large part of the holdings were much higher than they would have been if the leases had been executed with the present-day knowledge of the actual situation.

(B) *Renewals unprovided for.*—At the time the combination was made, the practice was in vogue of charging all renewals to capital account, in other words, depending on appreciation to take care of depreciation. It has been since demonstrated that earnings have not increased at a rate sufficiently rapid to take care of increased service as well as constantly increasing cost of operation and the demands of a pyramided capital account. The fact that only a small part of the necessary renewals have been provided for out of earnings in the financial accounting of the company is the fundamental defect of the system.

To correct this defect and at the same time meet the demands for adequate service and new capital for improvements, is the main financial problem. Experience with other properties would indicate that if new capital is to be used for rehabilitation, then the old capital account must be reduced by an equal or even larger amount, or if the future earnings are to be called upon to supply funds for past depreciation, then the future return on the present actual investment in the property must be reduced by a corresponding amount. In other words, if a reorganization with a reduced capital is impracticable, then future dividends must be sacrificed or reduced until the property is brought up to full normal operating efficiency, and the profits at one time expected in addition to actual interest requirements must be deferred until the density of traffic considerably increases.

The old order of financial requirements during the promotion period was (1) Profit, (2) Service, (3) Maintenance with no provision for depreciation. The new order for established* public properties should be (1) Adequate service, (2) Maintenance and renewals, (3) Interest on actual present investment, (4) Protection for new capital, and (5) Profit. But before this order can be established, the problem of what to do with past depreciation must be solved. To do this, the first effort must be to have the actual owners of the property provide the money for rehabilitation either by advancing it out of past profits or by agreeing to reduce dividends in the future until the rehabilitation fund is provided. If neither of these plans are practicable, then the property should be reorganized starting with its present depreciated value and adding to this value, the amount necessary to rehabilitate the property with suitable provisions for maintenance, renewals and extensions.

(C) The *Holding Companies.*—As a matter of fact, the Pittsburg Railways Co. would have failed long ago in carrying its burden of fixed charges if it had not been for the holding company, The Philadelphia Co., and the holding company to the holding company, The United Railways Investment Co. A large part of the stock of the Pittsburg Railways Co. and of the underlying companies comprising the system which it operates, is owned by The Philadelphia Co., which also owns valuable

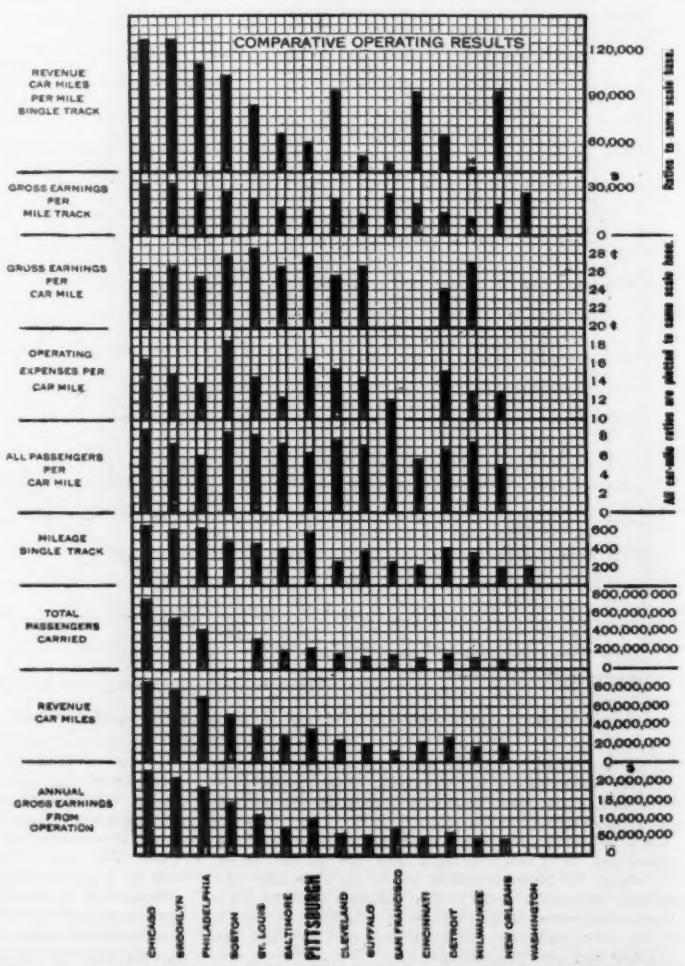


FIG. 5. COMPARATIVE OPERATING RESULTS OF STREET-RAILWAY SYSTEMS IN 15 AMERICAN CITIES.

*The percentages in the two tables will not add up to 100% for each city, as the first table does not include percentages for taxes and depreciation.

*That is, a property which is in operation and has demonstrated its ability, to give adequate service and earn reasonable fixed charges upon a fair valuation.

gas and electric properties in Pittsburg that are apparently on a paying basis. The result is that the deficit of the Pittsburg Railways Co. is carried as a floating debt by its parent company, the Philadelphia Co.

(B) *Perpetual Franchises.*—Most of the franchises of the underlying companies of the Pittsburg Railways Co. are claimed to be practically perpetual, in other words, there is no period of expiring franchises to be anticipated at which time new arrangements could be entered into that would include requirements for adequate service, public control and provisions for renewals out of earnings, which more mature public opinion will demand. In the meantime the companies justify their capitalization at a figure considerably in excess of the actual physical value of the property including reasonable development expenses by the value of their perpetual franchises. To defend this position, they must naturally deny the right of the community to regulate its service, to fix the fare or to demand transfers. Public opinion and legislation has not yet progressed far enough in Pennsylvania to definitely secure for the local community the right of public control of service, of rates and records, and therefore the traction situation in Pittsburg is still complicated by the "rights of perpetual franchises.

A REORGANIZED SURFACE SYSTEM.—The Surface System will continue to be unsatisfactory in its operation until the present leases are cancelled and the various properties reorganized into one system on the basis of their actual present value. Money to rehabilitate can then be invested on the same basis as capital for betterments and extensions and all actual investments can be assured a fair rate of return. Future depreciation can be taken care of by an equitable division of income between the requirements of service, maintenance, renewals, damages, taxes, interest and profit. To maintain such a balance, a competent regulating body will be found necessary to determine standards of construction and equipment, to control and check expenditures and to regulate service. Until the company, the city officials and the citizens of the Pittsburg district have succeeded in working out some such equitable balance, the surface railway situation will continue to be unsatisfactory. Immediate efforts should therefore be made to develop a comprehensive program for reorganization, for rehabilitation, for a protected actual investment, for adequate service and for public control of the present surface system.

III. Future Rapid Transit Developments.

The Pittsburg district must look for real "rapid transit" from (a) the building of subways and (b) the electrification of the steam suburban lines.

Elevated roads have been suggested for both the operation of the present surface cars and as a separate system, but as other communities now having elevated structures in their streets are making efforts to do away with them in favor of sub-surface construction, it is reasonable to assume that the future building of elevated structures for urban transportation is limited, particularly in downtown or congested sections.

SUBWAYS IN PITTSBURG.—Subways will, in the course of time, become desirable and even necessary in order to relieve the congestion of cars from the surface of the downtown streets, and in order to overcome the topographical disadvantages of hills and rivers which now divide the city into a number of separate communities. However, the advantages of a subway system from the standpoint of "rapid transit" will be but incidental as the sub-surface routes cannot be long. If the surface system is improved as it should be, the time required for the average ride on the trolley will not be excessive, and the fact that so many home communities are within 30 minutes, by trolley, of the business district makes the popular demand for subways in Pittsburg less than in other communities not so favored.

The fundamental need of subways in Pittsburg is to provide downtown terminals for electric suburban systems. To secure sufficient capacity to justify the investment the cars should be run in trains; and a transfer arrangement should be worked out so as to use the surface trolley system for collecting and distributing passengers throughout the districts contiguous to the subway or other rapid-transit routes. Considerable study should be given to the question of the exact location of the subway route and its terminals before final conclusions are made.

Subways should be built with money secured at the lowest possible interest rates. If private capital can be interested in a return of 5% and the financial arrangements can provide that the cost of the subway be amortized out of earnings (in such a way as to eventually become the property of the city even at the end of a long period) then the building of a subway by private capital is not impossible. But if private capital must have 6% interest, and to the actual cost of construction must be added any considerable amounts for promoters profits and for development expenses, then it will probably be found better for the city to secure legislation which will enable low interest-bearing bonds to be issued independent of the city's debt limit for the purpose of building a city-owned subway and thus relieve the subway of excessive fixed charges.

ELECTRIFICATION OF STEAM ROADS.—The steam lines perform no inconsiderable part in the transportation of passengers in the district. Three of the lines do the largest share of the suburban business and all are Pennsylvania R. R. lines.

As far as time is concerned, the present suburban steam lines are giving very fair rapid transit on their express trains. The drawback to this service, however, is its comparative infrequency and the lack of convenient downtown terminals. These two disadvantages can be corrected by electrifying the lines and using a subway route through the business center. Then the present railroad locations—allowing the operation of trains in the open air—and already serving the main suburban centers of the district, will be found particularly adapted for real rapid-transit purposes.

A COMPREHENSIVE PLAN.—The first requirement of future rapid-transit developments is that, from beginning to end, each part should fit into a carefully designed, comprehensive plan. As far as can be anticipated at the present time, this general plan should use the surface system as a convenient collecting and distributing medium for short hauls and the electrified steam lines and similar trunk lines for the more rapid long-haul business. This will leave the subways to furnish convenient terminals for preventing congestion on the streets in the central district and for through connections under the rivers to relieve the bridges and more effectively unite the three sides of the city. The entire system should be technically under one control and the transfer principle should be made use of to insure the most efficient density of traffic for each type of transportation.

IV. Legal Developments.

The task of producing a comprehensive system includes technical, legal and financial problems, the solution of which must proceed simultaneously and each may be said to be equally as important as the others. From a legal view point, it would seem that the developments should be (as near as can be outlined in advance) along the following general lines:

FIRST.—In order to prepare for and finally arrange a reorganization of the present system which will be fair to both the city and the company, a complete investigation should be made into the corporate history of the present system, either by the Secretary of Internal Affairs or by a properly authorized commission. The record resulting from this inquiry should show all the facts as to charters, franchises, agreements, leases, operating agreements, issues of stocks and bonds, the amount and distribution of earnings and all other information that should be a matter of public record.

Court decisions should determine the present status of all charter and franchise requirements which are not being carried out in regard to taxes on earnings, car licenses, street cleaning, paving maintenance, etc. In order to prevent any decisions or legislation which would tend toward confiscation of the property, arrangements should eventually be made for an official valuation of the property, but this valuation should not be made until the results can be definitely used in a final settlement.

SECOND.—In order to secure for the Pittsburg District the latest development in connection with the public control of public utilities, the Railroad Commission Act should be amended so as to secure as broad powers as have been delegated to the public-service commissions of other states covering the questions of capitalization, adequate service, rates, extensions, transfers, routing, joint use of property, renewals, and standard systems of records and accounts.

A Public Utility Bureau of the city should be authorized to accumulate information and to check the quality of service supplied by all public-utility corporations, this information to be used as a basis for improvement and future regulation.

THIRD.—With the idea of equipping the present city with machinery which will enable it to ultimately have complete control over its transit facilities, legislation should be prepared and passed as soon as practicable which will give the city the right to issue self-supporting bonds, independent of the debt limit for the purpose of building and operating or leasing subways and other rapid transit facilities.

The limits of Pittsburg should be extended so as to include as much as possible of the surrounding industrial and residence communities in a way to provide a centralized control of all public utilities and improvements, and for this Greater Pittsburg, the ultimate right to purchase, build and operate all necessary electric transportation systems should be secured and placed under the supervision of a properly qualified and authorized Transit Board.

Depositing Concrete by Gravity Chutes for Building Construction.

The delivery of concrete to the forms by chutes from an elevated hopper was described at some length in our issue of Dec. 3, 1910, and we have recently received some further details as to the plant and work for this system of construction. This later information is from notes made by Mr. Edward L. Holmes, engineer of the Ferrolite Co., of San Francisco, who investigated the matter for the purpose of a report to his company. It relates largely to the construction of the Union League Building (Los Angeles) under the patented system of the Concrete Appliances Co., of Los Angeles, Cal.

The building is nine stories high, 105 × 118 ft. in plan, and contains about 5,500 cu. yds. of concrete. The capacity of the supply hoppers for sand and stone was 200 cu. yds. capacity, and that of the cement hoppers in proportion. The materials should be fed to the mixer from bins or hoppers holding supply sufficient for at least half an hour's run, when continuous delivery of material by trams can be depended upon. A ½-yd. mixer was used, driven by a 15-HP. motor and running at 17 r. p. m. It discharged the batch in 10 secs. A 30-gal. water tank should be used, with at least 1½-in. feed pipe and 3-in. discharge pipe (with gate valve) for the required quick flow of water. The feed water should be delivered into the front of the mixer, and to meet the aggregate half-way, so as to ensure a preliminary dry mix. The concrete may be mixed and hoisted to a height of 64 ft. at the rate of a batch in 37 secs.

The tower used was 8 ft. square, 64 ft. high, and its hoist (with 12 cu. ft. bucket) was operated by a 15-HP. motor. The posts were 6 × 6 ins. in section, each composed of two sticks 2 × 4 ins. and 4 × 6 ins., placed so as to break joints. The boom supporting the pipe chutes was 45 ft. long and 30 ins. deep, weighing about 500 lbs. An 80-ft. boom could be made, and a 60-ft. boom with 20-ft. counterbalanced extension has been proposed. From the end of the boom, 30 ft. of free pipe can be handled, delivering the concrete into troughs which will carry it an additional 12 ft.

For the pipe chutes, the best angle is about 20° with the horizontal; but many different angles have been tried, to a minimum of 10°. The pipe can be handled easily at an angle of 60°, and has been used vertically for a drop of 100 ft. in laying a basement floor. The best size is 7 ins. diameter, made of No. 18 and No. 19 galvanized iron, riveted and soldered. The free end is in sections 10 ft. long, but it is convenient to have a few lengths of 6 ft. and 8 ft. The troughs for the swiveling hopper in the tower and at the end of the pipe chute are half-rounds of No. 18 galvanized iron, bound with small steel channels.

The concrete is mixed like grout or to such a consistency (like thick cream) that the stone will be held in suspension and the concrete will level off in the form. The mixture must not be very wet or "sloppy" and should be controlled by an experienced man at the water valve. Immediately before commencing to pour the concrete, half a skipful of water should be poured through the pipe. The pipe should then be fed as steadily as possible so as to keep it charged and not allow any intervals between the batches. When pouring is stopped, the pipe should be washed out with two skips of water. An inspection of the concrete showed it to be very uniform and dense.

As a result of the inspection of the gravity system on the work above described Mr. Holmes adopted a similar plant for the erection of two large reinforced-concrete storehouses for the U. S. Army supply depot at Fort Mason, Cal., for which buildings the Ferrolite Co. had the contract. These are three-story buildings 140 × 200 ft.

The plant now being installed provides for the delivery of concrete at any point in the structure at the rate of 30 cu. yds. per hour. The tower is 8 ft. square and 140 ft. high, rigged with a 60-ft. trussed wooden boom having a 20-ft. extension from which the pipe line is hung. This will deliver concrete at a radius of 130 ft. from the base of the tower and at all intermediate points. The boom will be fitted with a traveling hoist by which form work and reinforcing steel will be handled and placed. A concrete mixer of ¾-yd. capacity will be charged from bunkers or bins, and will deliver the concrete into a hoisting bucket of 20 cu. ft. capacity. This will be operated by a 30-HP. motor for the tower hoist.

Reinforced-Concrete Pressure Pipe on the Umatilla Project, Ore., U. S. Reclamation Service

By HERBERT D. NEWELL,* Assoc. M. Am. Soc. C. E.

In the Umatilla Project of the U. S. Reclamation Service, in the northwestern part of Oregon, a number of pressure pipes are required to distribute the water, on account of the irregular topography of the irrigable lands. When the plans of the distribution system were first being prepared some doubt existed as to the kind of pipe to be used. Wood pipe was admitted to be the cheapest in first cost, but since the pipe would be in use only about seven months each year and would be dry wholly or in part for five months, it was feared that the life of wood pipe would be short. Steel pipe was considered to be rather expensive in first cost; moreover, some uncertainty existed as to its length of life in this soil. It was finally decided to experiment with concrete pipe. The experiments were carried on under the immediate direction of Mr. E. G. Hopson, then Assistant Supervising Engineer, now Supervising Engineer, Mr. D. C. Henny being Supervising Engineer at the time the experiments were made.

The pipe line first under consideration was one of 46-in. inside diameter, which would have a length of 4,700 ft., and would be subjected to a maximum head of about 55 ft. Experiments on two test sections were made at Portland, Ore., in the summer and fall of 1906. They seemed to warrant the following conclusions, which actual construction and operation have since shown to be correct:

(a) That the steel used for circumferential reinforcement may be subjected to a stress of about 12,500 lbs. per sq. in. without causing appreciable leakage in the concrete.

(b) That the cement joint used could be depended upon to resist a pressure of 30 lbs. per sq. in.

(c) That a 3-in. shell was amply sufficient to resist internal pressure and ordinary handling.

(d) That a coat of plaster ½-in. thick well applied would successfully resist percolation under pressures corresponding to about 100 ft. head.

Forms

Designs for the forms were prepared in the Supervising Engineer's office in the early fall of 1906. Fig. 1 gives a good general view of the forms, and Fig. 2 shows the forms used for making collars. The main forms consist of an inner core of ¼-in. steel plate 8 ft. in length with a key piece. The inner core is hinged to permit its being collapsed when the key piece is removed. It was first planned to place a ½-in. plaster coat on the inside of the pipe, so the outside diameter of the core was made 47 ins. in order that the finished pipe might have a diameter of 46 ins. The outer forms are segmental, three segments making a circumference, the segments being 2 ft. high. They are made of ⅛-in. steel plate, stiffened by 2 × 3 × 3/16-in. angles. The inside diameter of the outer forms is 52 ins.

The first cost of the forms, including 50 cast-iron base rings, was nearly $1,900. The workmanship on the forms as originally delivered was imperfect. The inner core was not cylindrical and the outer segments were not true. As a result pipe made the first season had a shell of varying thickness, and there were often pronounced offsets, sometimes nearly as much as an inch, where one segment joined another. During the winter of 1907-8 the forms were sent to Portland to be trued up and put in good condition. The diameter of the inner core was reduced from 47 ins. to 46 ins., and necessary changes were made to the base rings. The cost of these changes was about $1,125, making the total cost of the forms to date slightly over $3,000. The forms were used during the season of 1908 and 1909 with good satisfaction, and are to-day in good condition after 21,000 ft. of pipe have been made.

FIG. 1. STEEL FORMS AND REINFORCEMENT FOR REINFORCED-CONCRETE PRESSURE PIPE, UMATILLA PROJECT, U. S. RECLAMATION SERVICE.

COLLARS.—The collars were of concrete, the same mixture being used as for the pipe. They were 3 ins. wide and 3 ins. thick. The first season they were reinforced with No. 13 expanded metal. This did not prove entirely satisfactory as there developed a tendency for the concrete to separate from the reinforcement. In other words, unless the collar remained in the form until thoroughly set, quite a percentage would split along the face of the reinforcing belt. Again, in making the joint in the field the expanded metal proved somewhat brittle.

The second season, in 1908, the collars were reinforced with two pieces of 5/16-in. mild steel wire hooked at the ends. These were cheaper than the expanded metal and were free from the tendency of splitting along the plane of reinforcement. However, collars reinforced with either expanded metal or with 5/16-in. wire proved weak unless carefully handled.

The third season, in 1909, all collars used where the head acting on the pipe was over 50 ft. were reinforced with No. 3 rib stud supplied by the Trussed Concrete Steel Co. Although this reinforcement contained an unnecessary amount of metal, it was the only standard article at hand and proved very satisfactory.

In some cases collars have been cast in the field after the pipe has been laid. In such cases either steel wire or the rib stud has been used for reinforcement. The form used is flexible and can be wrapped around the pipe like a belt. A drawing of the form is shown in Fig. 5. This collar has proved thoroughly satisfactory. It appears, however, to call for fully as careful workmanship as the collar cast in the yard.

Pipe Making

IN 1907.—The work of making pipe for the M pipe line* began at Hermiston, Ore., late in the Fall of 1906. The experience of the first six weeks was unsatisfactory. The work was expensive, and it was found that pipe could not be advantageously cast in cold weather on account of the slow setting of the cement, which made it impossible to remove the forms for several days. The work was discontinued early in January, 1907, and nothing was done until the middle of May, 1907, when the making of pipe was

*All pipe tabulated in accompanying Table I., p. 210.

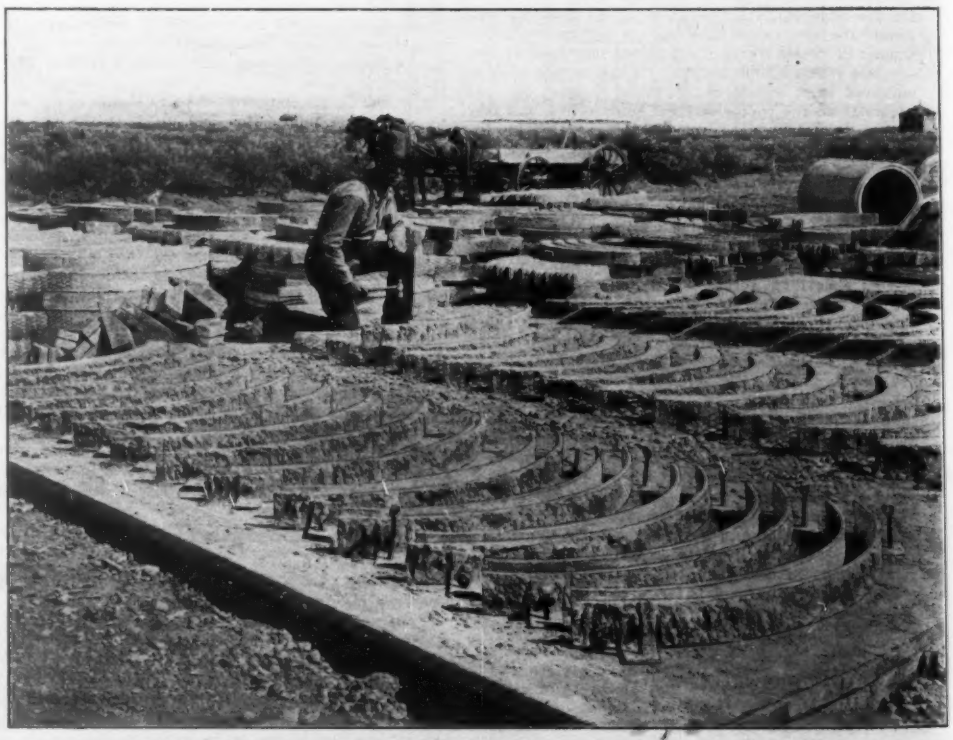


FIG. 2. FORMS FOR PIPE COLLARS FOR REINFORCED-CONCRETE PIPE.

*Project Engineer, U. S. Reclamation Service, Hermiston, Ore.

started in earnest, Mr. A. P. Garner being in charge.

With only twelve forms available it quickly developed that in order to give the concrete sufficient time in which to set only six pipes could be regularly made each day. The pipe were cast with a nominal thickness of shell of 2½ ins. with the expectation that ½-in. of mortar would be added on the inside. It was soon found, however, that a mortar coating on the inside of the pipe was very expensive, and the work was not satisfactory on account of the difficulty in getting a good bond. It was decided then to discontinue plastering, and fully 85% of the pipe in the M line has a shell nominally 2½ ins. thick. However, on account of the inaccuracy of the forms, the shell of the pipe was not of uniform thickness, there being frequent offsets at the junction of the different segments of the outside form, so in many cases the minimum thickness of shell was not more than 2 ins., and possibly a trifle less. The joints made in 1907 and 1908 were essentially similar to that shown in Fig. 6.

While the work of making 46-in. pipe was in progress it was decided to build about 3,000 lin. ft. of 30-in. concrete pipe. For this purpose wooden forms were built on the project, as shown in Fig. 3. The pipe was cast in 4-ft. lengths with a bevel and tongue joint and a thickness of shell of 3 ins. The inside form was made in two main segments, the cylinder being completed by means of a key piece. The outside form was in three parts, which were assembled by bolts. Both inner and outer forms were lined with No. 26 sheet steel. Fig. 7 shows the standard type of joint for 30-in. pipe when subjected to a head of 35 ft. or less. When the head is more than 35 ft., reinforced collars are used cast directly on to the pipe after they are laid.

Pipe making was discontinued in October, 1907. During the season 4,832 lin. ft. of 46 and 47-in. concrete pipe were made, and 3,868 lin. ft. of 30-in. pipe.

Considering one sack of cement as 0.9 cu. ft., the proportions by volume were approximately 1 part cement, 2.3 parts sand and 3 parts gravel. The sand was a dark blue sand, obtained locally. It was very clean, rather uniform in size, and of medium coarseness. The gravel all passed a screen of 1-in. mesh, and was rejected by a screen of ¼-in. mesh.

The reinforcement used consisted of 5/16-in. mild steel wire wound on a drum into a helical coil. The spacing was such as to permit a maximum stress of about 12,000 lbs. per sq. in. The coils used during the season of 1907 for 47-in. pipe were made by the Portland Wire and Iron Works, who received 4½ cts. a lb. for the manufactured coil, and furnished all labor, materials and appliances. A second contract was entered into with the same company for reinforcement for 30-in. pipe. Under this contract 5½ cts. per lb. was paid. A view of the manufactured coils is shown in Figs. 1 and 4.

The trench was excavated in the fall of 1907. Laying pipe for the M pipe line began in November, 1907, and the line was completed Feb. 1, 1908. Its diameter was 47 ins., length 4,680 ft., and maximum head 55 ft. The line was tested in the spring of 1908. There were a number of minor leaks, and one sufficiently pronounced to warrant an examination. It was found that leakage resulted from a defective collar which was placed when the temperature was about zero. This leakage was easily repaired and the line filled. It has been in use three seasons and has given complete satisfaction, nothing having been spent for repairs. It is found that there is some leakage when water is admitted in the spring, but as the weather gets warmer the leakage disappears. Again, a little leakage may be perceptible in the morning, and in the warmer part of the day it will entirely cease.

The 30-in. pipe was used in laying the D_3, D_2 and K pipe lines listed in Table I.

IN 1908.—The experience with the pipe lines laid during the winter of 1907 was sufficiently gratifying to warrant the making of concrete pipe during the season of 1908; 7,056 lin. ft. of 46-in. concrete pipe were made, and 9,216 lin. ft. of 30-in. pipe. The cost of 46-in. pipe in the yard, exclusive of reinforcement, was about $1.56 per lin. ft. for labor and material, and $2.24 per lin. ft. reinforcement included. The cost of 30-in. pipe without reinforcement was about 87 cts. per lin. ft., with reinforcement about $1.25 per lin. ft. The foregoing figures do not include the general expense charge.*

The mixture of concrete was the same as the previous year. The reinforcement was made by force account, and cost $0.04 per lb. for the completed coil. The 46-in. pipe was used in laying the O_1 and R_2 pipe lines, and the 30-in. pipe in laying the O_2, R_3 and B lines, all listed in Table I.

IN 1909.—The experience of the two previous seasons caused the engineers to consider favorably the idea of using concrete pipe for the R_1 pipe line. This would have an inside diameter of 46 ins., a length of over 9,800 ft., and would act under a maximum head of 110 ft. There was no doubt whatever that the pipe would be satisfactory for heads up to 75 ft. In order to determine whether or not the pipe would be satisfactory under a higher head, experiments were made in the spring of 1909.

Four test sections of pipe were made. These sections had an interior diameter of 46 ins., a thickness of shell of 3 ins., and a length of 4 ft. Considering one sack of cement equivalent to 0.9 cu. ft. the proportions by volume of the materials forming the concrete were 1 part cement, 1.44 parts sand and 2 parts gravel. The sand and gravel were similar to that used the two preceding seasons. All the test sections were reinforced with a double coil of 5/16-in. wire with 1¼-in. spacing. An effort was made to obtain wire of 13/32-in. diameter, in which case a single coil would have sufficed. The Portland market was unable to furnish wire of the desired size, so it was necessary to make use of 5/16-in. wire which was in stock, and in order to obtain sufficient strength it was necessary to use a double coil. As an important feature of the test was to determine the strength of the joint, the four sections were joined together in pairs, making two sections 8 ft. long, the joint being made as nearly as possible under conditions which would be approximated in the field.

The joint consisted of two parts, an outside collar which was placed first and cemented to the pipe with mortar composed of 1 part cement and 2 parts sand. After the cement joint had set, the inside joint was completed, using a mortar composed of 1 part cement and 1½ parts sand. The collars were reinforced with No. 3 rib stud made by the Trussed Concrete Steel Co. One collar was made of three segments cast in molds, seasoned, and afterwards cemented to the pipe. The other collar was cast directly on the pipe. Figs. 3 and 4 show the type of joint used. The tests showed that:

(a) 46-in. concrete pipe with a 3-in. shell would stand pressures of 50 lbs. per sq. in. without excessive percolation.

(b) That both types of collar were satisfactory.

The tests were deemed sufficiently satisfactory to warrant building the entire line of concrete. During the season of 1909, 9,216 lin. ft. of 46-in. reinforced-concrete pipe were made, having an average cost per lineal foot of $1.72, exclusive of reinforcement, and $2.97 including reinforcement. During that season 6,360 lin. ft. of 30-in. reinforced-concrete pipe were made, having an average cost per lineal foot of $1.02, exclusive of reinforcement, and $1.26 reinforcement included. The reinforcement was made by force account at a cost of $0.028 per lb. for the completed coil. The foregoing figures do not include the general expense charge. The 46-in. pipe were used for the R_1 line and the 30-in. pipe for the R_4 and D_1 lines.

The R_1 pipe had a diameter of 46 ins., a length of 9,831 ft., and a maximum head of 110 ft. The work of laying began in November, 1909, and the line was finished in January, 1910. The pipe was tested on Feb. 28, 1910, it being filled in two hours and forty minutes. There were no mishaps and no leakage was apparent in that portion of the line subjected to maximum pressure. One or two slight leaks developed where the head was about 60 ft. These were repaired

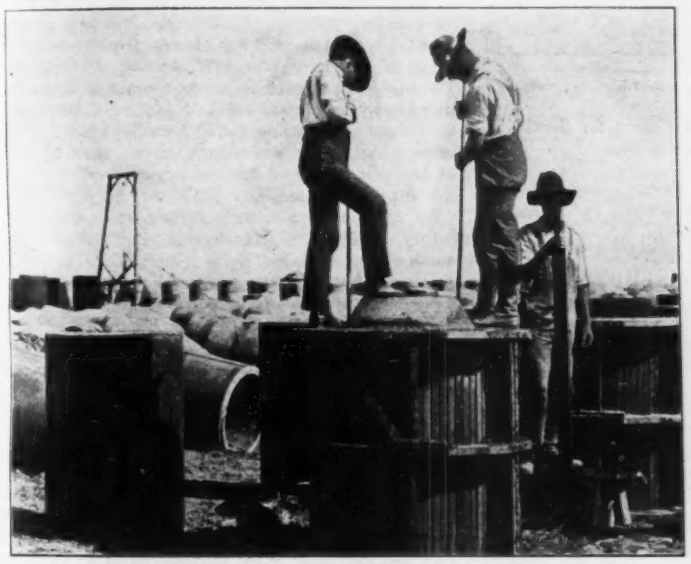


FIG. 3. WOODEN FORMS USED FOR 30-IN. PIPE.

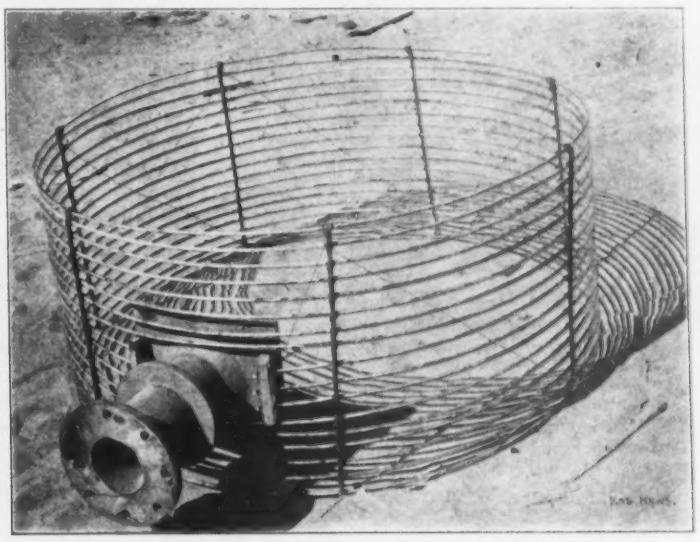


FIG. 4. REINFORCING COILS FOR 30-IN. PIPE.

*The general expense charge includes all expenses which cannot be directly charged to some feature. For example, it includes administration of project office, and all expenses of the offices of the Director, Supervising Engineer and Transportation Office.

at a cost of less than $10. The line was in continuous use during the season of 1910 and gave perfect satisfaction.

A full detailed statement of the cost of laying the R_1 and R_2 pipe lines is shown in Tables II.-III.

During the season of 1910 about 4,000 lin. ft. of 30-in. pipe were made for the T_1 and T_2 pipe lines listed in Table I.

It has been the general practice to give all pipe subjected to a pressure of more than 12 to 15 lbs. one or more coats of cement grout. This has proved helpful in decreasing percolation through the pipe, particularly where the pipe

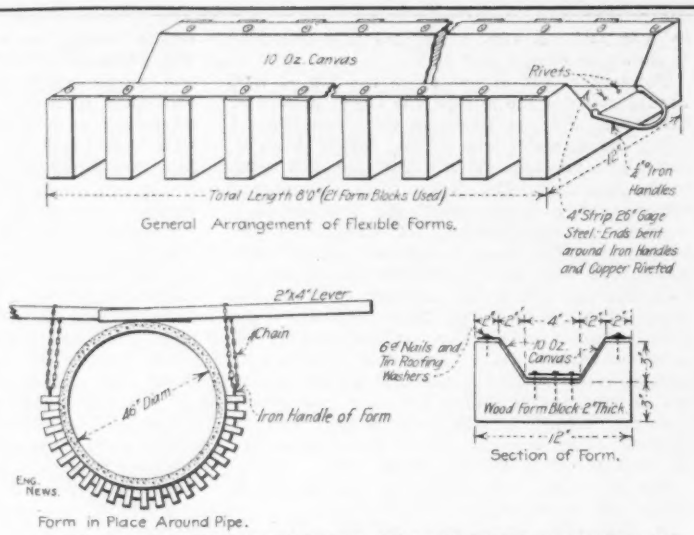


FIG. 5. FLEXIBLE FORMS FOR COLLARS ON THE UMATILLA REINFORCED-CONCRETE PIPE.

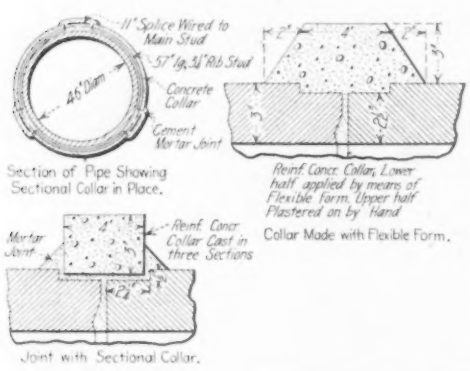

11" Splice Wired to Main Stud
57" lg. 3/4" Rib Stud
46" Diam.
Concrete Collar
Cement Mortar Joint
Section of Pipe Showing Sectional Collar in Place.
Reinf. Concr. Collar, Lower half applied by means of Flexible Form, Upper half Plastered on by Hand
Collar Made with Flexible Form.
Mortar Joint
Reinf. Concr. Collar Cast in three Sections
Joint with Sectional Collar.

Fig. 6. Detail of Joints and Collars for the 46-in. Reinforced-Concrete Pipe.

is made of a mixture rather lean in cement. About one-half a bucket of cement is stirred into two-thirds of a bucket of water. This will give a full bucket of a mixture having about the consistency of cream. Tests have been made on various coatings which were painted on the inside of the pipe. The experience has been that the cement grout is much cheaper and at least as effective.

To the cost per lineal foot given in the accompanying tables there should ultimately be added about $0.08 per lin. ft. for depreciation of forms for the 46-in. pipe, and probably $0.10 or $0.12 per lin. ft. for all other depreciation.

The experience with reinforced-concrete pipe on this project thus far has been thoroughly satisfactory. Much credit for the uniform success of the various pipe lines is due to Mr. A. P. Garner, foreman in charge, who has performed

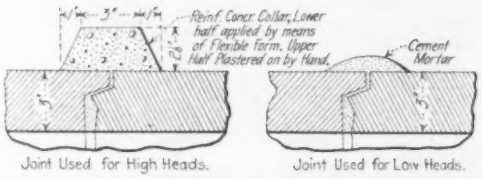

Reinf. Concr. Collar, Lower half applied by means of Flexible Form, Upper Half Plastered on by Hand.
Joint Used for High Heads.
Cement Mortar
Joint Used for Low Heads.

Fig. 7. Details of Joints and Collars for the 30-in. Reinforced-Concrete Pipe.

thorough and conscientious work throughout, and has at all times shown an ability to overcome difficulties as they have arisen.

TABLE I.—TABULATION OF REINFORCED-CONCRETE PIPE LAID.

Umatilla Project, Ore., U. S. Reclamation Service.

Line.	Inside dia., ins.	Max. head, ft.	Length, ft.	Cost per lin. ft. in place ready for use. Excluding general expense.	Including general expense.
R_1	46	110	9,831	$4.43	$5.17
R_2	46	15	1,284	3.26	4.04
*M	46 & 47	55	4,680	5.43	6.14
O_1	46	36	5,312	3.86	4.51
D_1	30	45	5,330	2.25	2.69
D_2	30	22	1,724	2.37	2.67
†D_3	30	35	1,395	3.09	3.51
O_2	30	26	3,556	2.45	2.93
R_3	30	25	3,645	2.04	2.43
‡B	30	55	932	3.31	4.24
R_4	30	18	1,622	1.96	2.30
K	30	9	524	2.28	2.57
§T_1	30	8	1,398	2.44	2.66
§T_2	30	18	2,495	2.62	2.83

*High cost due to its being the first line laid, and to the fact that it is charged with preliminary and experimental work.

†High cost due to rock in trench and to railroad crossing.

‡High cost due to rock in trench and to presence of water.

§High cost due to mixing by hand with a small crew, and to a long haul over sandy roads.

THE MARINE COMMERCE OF DULUTH-SUPERIOR Harbor for 1910 showed an increase over the previous year and the largest annual freight movement for any year in the history of the port with the exception of 1907. The statistics for the past four years are as follows:

	Total receipts and shipments (short tons).	Total valuation of receipts and shipments.
1907	34,786,705	$287,529,694
1908	23,797,162	223,114,320
1909	32,529,301	261,509,159
1910	36,684,578	284,049,072

Every material shipped through the port showed an increase over 1909 except wheat and other grain, which dropped off nearly 32 million bushels, a result of the reduced production of the year 1910.

TABLE II.—R_1 PIPE—DETAILED STATEMENT OF COST.

46-in. Reinforced Concrete, 9,831 ft. long—Maximum head, 110 ft.

Item.	Total cost.	Cost, lin. ft.
Engineering	$471.17	$0.048
Labor: Cleaning sage brush from line	59.07	.006
Excavating trench	2,336.13	.238
Backfilling and protecting line with brush	1,884.92	.192
Hauling pipe from pipe yard	2,901.75	.296
Laying pipe and making joints	3,817.59	.388
Tests on experimental sections	341.21	.034
Painting pipe with cement grout	427.00	.043
Priming pipe	22.77	.002
Miscellaneous and miscellaneous hauling	877.47	.089
Cement pipe, charge from mfg. plant.	28,534.14	2.905
Materials, cement	680.57	.069
Miscellaneous materials and supplies.	780.04	.080
Castings, valves and manholes	369.45	.037
Total	$43,523.28	$4.427
General Expenses	7,282.26	.741
Grand Total	$50,805.54	$5.168

NOTE: Pipe line is located about three miles from yard where pipe were made. Roads were sandy. Sand for mortar was sacked and hauled about three miles. Weather too cold for best work. Crew laid off twice—total, 11 days. Laying pipes in trench began Nov. 2, 1909, and was finished Dec. 31, 1909. Placing collars and making joints began Nov. 14, 1909, and was finished Jan. 11, 1910.

Mortar mixed with hot water. Weight of salt added to water about 10% of weight of water used. Ends of pipe thawed before making joints. Minimum temperature 2° below zero, temperature while work was in progress 12° above zero or warmer, but seldom much above freezing point. Pipe was in continuous use during 1910, giving complete satisfaction.

Average force, 35 men and 7 teams. Wages: Foreman, $150 per month; carpenters and blacksmith, $3.40; laborers, $2.20 to $3 per 8-hr. day; 2-horse team and driver, $4.25 per day.

Trench excavated by contract. Unit price, earth, $0.1145 per cu. yd.; cement gravel, $1 per cu. yd.

Fourth Annual Meeting of the Indiana Sanitary and Water Supply Association.*

Conservation and purity of water supplies, stream pollution, sewerage purification, waterworks management, and public utility commissions were among the principal topics discussed at the fourth annual meeting of the Indiana Sanitary and Water Supply Association, held at Indianapolis, Feb. 9 and 10, 1911.

In the course of his annual address Mr. H. E. Barnard, Chemist, Indiana State Board of Health, deplored the manner in which the streams of the state have been polluted. He reviewed the work of the association during the year and said that notwithstanding what had been accomplished there is still a wider field for activity. He suggested that an effort be made to interest and secure the co-operation of all the health officers of the state, city officials, engineers and water companies as a movement conducive to a better water-supply. The president appointed a committee to solicit the cooperation and membership of the officials interested in the question of conservation and purification of water-supplies.

Mr. F. C. Jordan, Secretary of the Association, made a report showing a membership of 92 water-works boards, out of an eligible five hundred. The association's finances were shown to be in good shape.

"The Successful Treatment of White River by Mechanical Filtration" was the subject of the first paper, presented by Henry Drach, Superintendent Anderson Water-Works. Mr. Drach cited the many experiments made from the time the plant was first installed and explained the present plan of cleaning the filtration beds. He stated that tests show that an average of 98% of the impurities of the water were removed by the filtration process.

Dr. J. H. Simonds, Superintendent of the Laboratory of Hygiene, gave a talk on "Typhoid Epidemics" in Indiana. He referred to the epidemic at Indiana University and the Boys Reform School last summer; the former he attributed to flies that bred in an open privy vault near a restaurant where students dined and the latter to using water from a spring contaminated by leakage from a sewer. By careful deduction he traced the source of the disease among the students in both schools.

At the banquet Thursday evening, the typhoid epidemic question was discussed by Dr. C. S. Wood, City Sanitarian for Indianapolis, Dr. J. N. Hurty, Secretary State Health Board and Dr. Edwin Barlow of the University of Illinois, each speaker showing that typhoid is due to poor water supply.

Water-Works Management.

A paper read at the opening of the Friday morning session by Mr. C. H. Hurd, Chief Engineer Indianapolis Water Co., received the closest attention and brought a hearty discussion and the

*Reported by Mr. R. D. Fisher, Assistant City Civil Engineer, Indianapolis, Ind.

TABLE III.—R_2 PIPE—DETAILED STATEMENT OF COST.

30-in. Reinforced Concrete, 3,645 ft. long. Maximum head, 25 ft.

Item.	Total cost.	Cost, lin. ft.
Engineering	$57.64	$0.016
Labor: Clearing sagebrush from line.	69.51	.019
Excavating trench	712.74	.196
Backfilling and protecting line with brush	212.77	.058
Hauling pipe from pipe yard	670.56	.184
Laying pipe and making joints	755.86	.208
Miscellaneous and miscellaneous hauling	327.39	.090
Cement pipe, charge from mfg. plant.	4,465.52	1.225
Materials, cement	54.82	.015
Miscellaneous materials and supplies.	42.63	.011
Castings, valves, manholes	66.50	.018
Total	$7,435.94	$2.040
General Expenses	1,428.45	.392
Grand Total	$8,864.39	$2.432

NOTE: Line is located about 2½ miles from yard where pipe were made. Roads were sandy. Water was hauled about 2½ miles. Mortar was mixed with hot water, and weight of salt added to water was about 10% of weight of water used. Ends of pipe were heated before making joints. The line was laid in January and February, 1909, and was in continuous use during 1910, giving complete satisfaction. About 3,800 cu. yds. sandy loam were moved.

Wages: Foreman, $150 per month; carpenters and blacksmiths, $3.40; laborers, $2.20 to $2.80 per 8-hr. day; 2-horse team and driver, $4.25 per day.

relating of experiences. Mr. Hurd said that the successful operation of a water-works plant means not only economy in operation, but also economy of the highest order in the exercise of judgment and foresight, both in the character of construction and design, and its financial operations with a view to future growth. The physical plant is represented by the equipment necessary for its operation; the financial plant is represented by the investment and the returns upon such investment.

In the selection of equipment for pumping stations considerable weight should be given to the conditions of service as well as individual efficiency. For example, large triple-expansion pumping engines, on account of their high duty, may show a good return, providing they are in continuous service and always operating at their full load; but if they are to stand idle for any considerable portion of time, or if operated at lower capacities, it is obvious that the fixed charges, which are going on continuously, will very much increase the unit cost for the year's output—and it is probable that a less expensive installation would show a better over all economy.

In making improvements it should be remembered that a change in one part of the plant will have a more or less direct influence upon another. If it is desirable to install low duty engines at a lesser cost, it will be necessary to have larger boiler capacity and greater cost of boiler-room, labor and coal handling. Saving in one department will not always mean a net saving in the entire plant. What is true in connection with pumping equipment is also true in reference to filtration plants; each plant presents an individual problem, and a system which is advantageous for one will not necessarily give good results in another.

Mr. Howard M. Dill, Superintendent of the Richmond Water-Works, read a paper on "The Care of Public Fire Hydrants." He condemned the use of salt to prevent freezing because of deleterious effect on the roads. The importance of having duplicate repair parts was emphasized.

In the discussion of this paper the association went on record as favoring distinct rules by which fire hydrants can be used for no other purpose than fire. Water companies that have contracts for fire plugs with cities were urged to incorporate in their contracts that hydrants are never to be opened except in case of fire or under the direction of company men.

"Labor-Saving Devices in Water-Works Plants" was the subject of an interesting paper presented by F. C. Jordan, of the Indianapolis Water Co. Among other things Mr. Jordon advocated the use of recording gages wherever they can be installed. In addition to office helps he named a number of labor-saving devices which materially decrease the cost of operation and construction. He referred in particular to the detectorphone, by the aid of which leaks are located with a reasonable degree of accuracy. He said foreman Helfrich, of his company, had perfected an attachment for the Smith tapping machine whereby it is not necessary to use the ordinary ratchet; the operation of the machine from the surface of the street is made possible. This attachment consists of a windlass, cog wheels and shaft, and "not only saves time but also a large expense for the repairing of the pavement, as it is only necessary to cut a hole of sufficient size to admit the tapping machine."

Mr. Jordan said that on account of the growing scarcity of labor reliable ditch digging devices to be used in narrow streets were used to advantage. He also said the installation of electric or hand-power cranes is highly recommended in the stations. Electrically-operated valves are such labor savers that it is surprising that they are not installed to a greater extent. He also recommended the use of electricity for power in the smaller plants as an economical measure. He named a plant, a booster station, pumping 750,000 gals. per day, operated by one man.

Mr. H. W. Klausman, City Civil Engineer of Indianapolis, read a paper on "Street and Sewer Flushing." Mr. Klausman insisted that the streets and sewers were being greatly injured by flushing the refuse of the streets into the sewers. "The water," he said, "washes all the grouting from the crevices in a brick street, leaving the edges exposed, to be chipped off by heavy vehicles. The refuse of the streets should be hauled away instead of flushed into sewers."

A number of papers and illustrated lectures were given on various topics relating to water purification, stream pollution and sewerage purification.

At a free luncheon given by the association Hon. C. W. Fairbanks addressed the members on the subject of timber conservation and reforestation. He believed that the forests have much to do with the water-supply.

Mr. George W. Fuller, of New York City, made an interesting talk on the causes of intestinal disease directly traceable to impure water and lack of sanitary care.

At the closing session, Mr. A. H. Kennedy of Rockfort, urged the association to advocate a public-utilities law as the only relief for the evils from which water-works companies suffer.

Mr. Kennedy was followed by Prof. Wiley, of Purdue University, who pointed out the mistake water companies make by furnishing "free water." Whether the service is furnished by a private corporation or a municipal plant, some one pays for every gallon of water pumped and the practice of furnishing free water to city institutions is bad in principle and results in great waste. Contracts should be made so as to account for every gallon of water furnished. In no other way can the consumer secure the rate to which he is entitled.

The following officers were elected: President, F. C. Jordan, Indianapolis; Secretary, Wm. F. King, Indianapolis; Vice-Presidents, D. R. Gwinn, Terre Haute, E. L. Loomis, Valparaiso, Robert L. Sackett, Lafayette, C. R. Semans, Washington and Henry Drach, Anderson.

Reasons for Public Development and Control of Water Power in New York State.

The annual report of the State Water Supply Commission of New York for the year 1910, just submitted to the Legislature, contains a series of reasons for State rather than private development and control of water power, as follows:

(1) Water power differs from every other form of power, in that it is constant and perpetual. Its development, particularly in the form of electrical energy, is in its infancy. It is impossible to predict its future value. Sound public policy demands that, as its most valuable resource, the State should retain the largest possible measure of control, so that the power may forever be employed for the public benefit.

(2) Experience everywhere proves conclusively that the prosperity of industries dependent upon water power is best served by State control, and all progress in legislation has been along this line.

(3) The public interest demands that there should be the fullest possible development of water powers. Such development can be brought about only by the State, since in many cases economy would not warrant it in private enterprises.

(4) The right to condemn lands for water storage purposes can be exercised only by the State and for the benefit of the public.

(5) The financial strength of the State enables it to borrow money to pay the cost of the work at a lower rate of interest than it would be possible for individuals to obtain.

(6) The State alone by assessment can compel each beneficiary of an improvement to pay a just proportion of the cost, and by State operation only can an equitable distribution of the stored water be made. Experience has shown that it is practically impossible for various reasons to combine competing private interests in the development and use of water power.

(7) The sanitary conditions which should be taken into consideration in storage reservoir construction and operation cannot be assured through private construction and control.

(8) Development and control by the State would promote new industries, while private development and operation promote existing industries only and tend to discourage new industries.

(9) The safety of dams built for water storage can be assured only by State construction in which it would be paramount to any question of expense.

(10) The supply of water available for power purposes is limited, thus creating a situation which invites the establishment of combinations tending to monopoly and harmful to the public interest. State control provides a complete barrier to such combinations.

(11) The benefits to navigable streams which should result from water storage can be assured only through State ownership and control of storage reservoirs.

(12) Under State control the shores of the lakes formed by storage reservoirs can be so treated and maintained as to make these lakes attractive health and pleasure resorts, thus benefiting surrounding communities instead of injuring them. Private owners have no business interest in this object and in fact pay little regard to it.

(13) Many miles of navigation may be added to the waters of the State by State control by thorough clearing of reservoir sites and the retention of a sufficient minimum depth of water in the reservoir at all times. Private control does not preserve this advantage.

(14) Storage under State control may be so managed as to bring about the establishment of new industrial communities by the utilization of the additional water power at or near the dam without diminishing the benefit to existing industries.

(15) Water-supplies for other than industrial purposes can be protected only through supervision by the State.

(16) By the adoption of a definite and comprehensive State policy of control, the location of roads, railroads and buildings in prospective reservoir sites can be prevented and a large part of the expense in the eventual purchase of the site can be avoided. This cannot be accomplished in any other way.

(17) Under State control the possible future needs of the canal system can be considered and economical provision made for them.

(18) The State alone can plan a comprehensive scheme of water power development and execute it in accordance with the relative importance of each project.

(19) Through the establishment of State control and development upon well defined and reasonable terms it is probable that the people will consent to the use of the State land in the Adirondack Park, which is absolutely necessary to the development of some of the most valuable water powers, and it is unlikely that the use of the land will be permitted for the purpose of private development and control.

A LONG-DISTANCE TELEPHONE SYSTEM claimed to be practicable for distances up to 5,000 miles, was exhibited during the convention of the National Independent Telephone Association, at Chicago, Feb. 8 to 10. This system is made possible by means of a special telephone repeater, which repeats from one circuit to another (as in telegraphy). It is claimed that in this way speech can be transmitted clearly and distinctly over distances impossible with the Bell instruments, besides securing better transmission with No. 10 copper wire than with the No. 8 wire used for the Bell instruments. Iron wire can be used also for distances of several hundred miles. Another device used in connection with this system is a long-distance high-power transmitter. The system is the invention of Mr. Charles Adams Randall, and is being introduced by Mr. Newell W. Bloss, contracting engineer, of Boston, Mass.

POLITICS IN THE OHIO STATE BOARD OF HEALTH.—Sanitarians the country over have for some years looked to the Ohio State Board of Health as one of the ablest and most progressive in the United States. Under Dr. Probst's general leadership as Secretary, with Mr. R. W. Pratt in charge of the engineering division and recently with Mr. B. R. Rickards as chief of laboratories, the Ohio organization has been a model one and a source of inspiration to many states in the middle West. In December, 1909, Mr. John W. Hill, of Cincinnati, at an earlier period connected with the Philadelphia Filtration Plant, was appointed a member of the board. With the death of two members of the board last summer power passed into new hands. On December first a committee, consisting of Mr. Hill and Dr. Warner, was appointed to investigate the affairs of the department. The committee's first step was to obtain a list of expenditures for the year. An inspection of the Secretary's office, the engineering department and the laboratories was then made, which altogether consumed forty-five minutes. A few days later eleven members of the staff, including Mr. Rickards, were dismissed on two days' notice. It was expressly stated that the work of the experts so dismissed was satisfactory. The ground assigned for the action was economy, but inquiries made on the ground by the secretary of the Ohio State Medical Association and others have failed to elicit any comprehensive reasons for it. The result can scarcely fail to be a demoralization of the work of this vital department of the state government. Self-respecting sanitary experts will hesitate long before accepting positions under this board unless it shall be radically reconstituted; and the bad effects of the affair will be felt everywhere in the general distrust of state and municipal positions which often deprives the community of the public services of the trained experts it so sorely needs.—Contributed by C.-E. A. W. to Journal of the American Public Health Association for January, 1911.

A Bridge Collapse Caused by a Remarkable Abutment Failure.

By CORNELIUS M. DAILY.*

On Oct. 25, 1910, a 200-ft. steel highway bridge over the Little Wabash River in White County, Ill., fell into the river a few days after completion. The fill for the south approach was finished and work on the north approach was being made at the time of the failure of the bridge. The south abutment slid into the river, moving about 29.5 ft. forward and 18.9 ft. down, collapsing the superstructure as shown on the accompanying photographs Figs. 2 and 3. The slip itself is shown by the views Figs. 4 and 5.

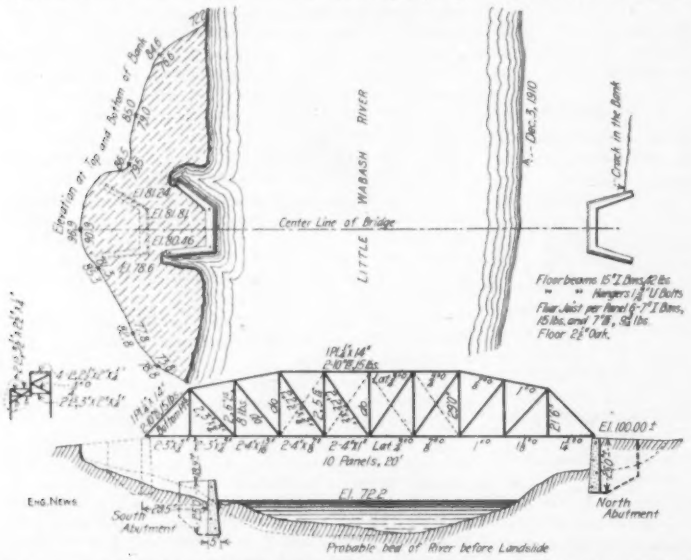

LITTLE WABASH RIVER
Center Line of Bridge
Elevation on Top and Bottom of Bank
El. 818.24
El. 815.81
El. 810.46
El. 788.6
A - Dec. 3, 1910
Crack in the Bank
Floor beams 15"I Bms, 42 lbs.
" " Hangers 1⅛" U Bolts
Flor Joist per Panel 6-7"I Bms, 15 lbs. and 7"I 8, 21 lbs.
Floor 2½" Oak.
10 Panels, 20'
El. 100.00 ±
El. 72.2
South Abutment
North Abutment
Probable bed of River before Landslide
Eng. News

FIG. 1. LOCATION SKETCH OF LITTLE WABASH BRIDGE WRECKED BY SLIPPING OF ABUTMENT.

As may be seen from the sketch, Fig. 1, the landslide accompanying the failure was about 150 ft. in length and over 40 ft. in width.

The bridge was built under the township organization. The Township Commisisoners simply bought a 200-ft. bridge from an Indiana bridge company, and thereby saved the expense of an engineer. The specifications embodied in the contract were as follows:

> Company agrees to furnish all the material and build and construct one bridge, 200 ft. long, 16-ft. roadway, set on concrete abutments 25 ft. high, four 21-ft. wings, and make dirt fill at the north end of bridge. The above bridge is to be composed of such sizes and materials as to carry a 6-in. reinforced-concrete floor at some future period, but a 2½-in. wood floor to be placed on for first use.

The contract price was $8,000.

After the collapse the commissioners employed the writer's firm, Daily & Beckelhimer, to investigate the wreck and determine if possible the cause of the failure. Our report, given the commissioners on Dec. 19, stated that the cause of the failure was the sliding of the south abutment into the river. Attention was called to the weakness of the structure.

Evidently the report made but very little impression, as the commissioners made another contract with the bridge company, giving them $3,000 more to rebuild the bridge, using all the old material which was found possible to repair. The new contract provides for steel tubes to replace the south abutment and an approach span 30 ft. long made of 10-in. I-beams, the approach span to be supported by the steel tubes at one end and a small concrete abutment at the other.

The writer found that the north abutment had settled about 0.15 ft. between Dec. 3 and Dec. 31, and a crack in the bank a few feet north of the north abutment, 1 in. wide on Dec. 3, had opened to nearly 3 ins. on Dec. 31. But the bridge company agreed to remedy this slight defect by placing a steel bar around the abutment and fastening the ends to some piling driven in the solid bank, and also drive a few piles in front of the troublesome abutment.

*Of Daily & Beckelhimer, Civil and Electrical Engineers; 4240 Shaw Ave., St. Louis, Mo.

HYPOCHLORITE-OF-LIME TREATMENT for the water supply of Des Moines, Ia., and Erie, Pa., has been adopted on account of a typhoid fever epidemic at each place. At Des Moines investigations have been made by Mr. Geo. W. Fuller, M. Am. Soc. C. E., and Dr. L. L. Lumsden, the latter of the U. S. Public Health and Marine-Hospital Service. At Erie an investigation has been made by a committee composed of Messrs. W. P. Mason, E. G. Smith and F. F. Westbrook.

TWO MORE BILLS REQUIRING ENGINEERS TO BE licensed have been introduced in the New York legislature. One introduced in the Assembly by Mr. Hoff (No. 309) on Feb. 1, was read once and referred to the Committee on General Laws. In the Senate, a bill (No. 291) was introduced by Mr. Gittins on Feb. 7 and was read twice and referred to the Committee on Public Education. The two bills are nearly identical and correspond closely to the bill framed by a Committee of the American Society of Civil Engineers, for use by any State in which the legislature deems the licensing of engineers essential.

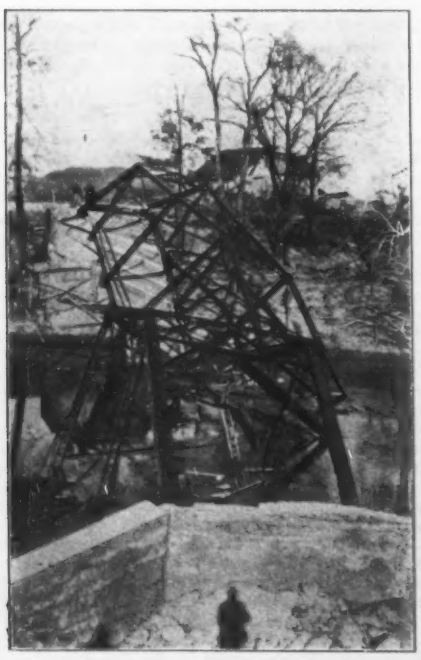


Fig. 2. Looking North from South Approach.

Fig. 3. Looking North from South Abutment.

FIGS. 2 AND 3. TWO VIEWS OF THE WRECKAGE OF LITTLE WABASH BRIDGE.

A Large Series of Full-Size Eyebar Tests.

In the construction of the large double-track cantilever bridge* of the Pittsburgh & Lake Erie Railroad over the Ohio River at Beaver, Pa., under Mr. Albert Lucius of New York City as consulting engineer, an unusually extensive series of full-size eyebar tests was made. The results of these tests are summarized below. They show materially higher figures than have ordinarily been obtained in the past, and they support those who oppose double specifications for manufactured material.

The specifications for this bridge departed from the customary practice of specifying desired strength, etc., for both the unforged bar and the finished eyebar. No requirement was fixed for the original bar, except that the composition and strength-qualities decided on by the manufacturer were to be communicated to the purchaser and his approval secured. Only the properties of the finished eyebars were specified, and to tell whether these were obtained frequent full-size tests were called for. The purchaser desired eyebars of

Ultimate tensile strength....56,000 to 66,000 lbs. per sq. in.
Elastic limit .....33,000 to 36,300 lbs. per sq. in.
Elongation .....12% in 10 ft.
No breaks in head allowed.

It was left to the contractor to select proper material to meet these figures. He ordered bars testing 64,000 to 72,000 ultimate, with 60% elastic limit, and elongation and reduction of area equal to those of ordinary structural steel; and, as may be seen from the tabulation farther on, the plain bars as received (i. e. the bars before forging into eyebars, and without annealing for the test) came up to these requirements almost exactly. Although these figures are not greatly in excess of those specified for the finished eyebar, yet the contractor's engineer considered that the desired product would be obtained from them. The results of the full-size tests of the finished eyebars confirmed this opinion, as stated below.

The eyebars in the bridge vary from 8 × 1⅝ ins. to 16 × 2⅛ ins. in section, and have pins up to 16-in. diameter. In all, 47 bars were tested. Five out of this number ran slightly under the specified figures, two showing an elastic limit below 30,000 lbs. per sq. in. (respectively, 29,290 and 29,850). Retests were made, upon bars of the same two heats, and these gave excellent results (respectively, 37,410 and 39,270 elastic limit, and other figures equally good). In averaging the results, these retests as well as the original tests have been included.

Further, two bars of the 47 broke in the head, but under circumstances which made this result natural. Both these bars were counters, of small width but connected to relatively large pins. One of the bars was 8 × 1⅝, with 20½-in. heads and pins of 12 and 10-in. diameter; the other was 8 × 1⅝-in., with 20-in. heads and pins of 12 and 10-in. diameter. Thus the section of head at the 12-in. pin was exactly equal to the body, in one case, and only 3% in excess in the other case. The usual experience is that net section of head must have 37½% excess over the body in order to ensure breaking in the body; and correspondingly the net section credited to these eyebars on the stress sheet is 1/1.375 or 72.7% of the actual body section. It would seem that on full-size test these bars should have exceptionally low strength. On the contrary their strengths, per square inch of actual body section, were 62,210 and 67,180 lbs., respectively, with elastic limit in due proportion. The effect of the excessive stress in the sides of the head in these bars is shown by the large stretch of the 12-in. pin-hole, and the action is further apparent on

*Described in our issue of Jan. 26, 1911.

RESULTS OF 47 FULL-SIZE EYEBAR TESTS AND SPECIMEN TESTS OF THE PLAIN BAR.

(Beaver Bridge eyebars. The specimen tests are the contractor's acceptance tests of the bar stock, while the eyebar tests are the railroad company's acceptance tests of the finished bars.)

	Specimen tests from plain bar.							Eyebars compared with plain bar.				
	As received.			Annealed.				Full-size eyebars.				
	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Change by annealing.	Minimum.	Maximum.	Average.	Change from unannealed specimen tests.	Change from annealed specimen tests.
Elastic limit	37,000	46,100	39,460	31,900	41,000	36,110	−8.5%	29,300	39,300	35,110	−11.0%	−2.8%
Ultimate strength	64,100	73,000	67,320	57,000	67,000	61,110	−9.5%	58,300	74,400	64,040	− 5.2%	+4.8%
Ratio $\frac{\text{El. Lim.}}{\text{Ult. str.}}$	52.4%	66.9%	58.5%	52.8%	63.5%	59.1%	.....	46.4%	61.5%	54.9%	− 6.2%	−7.1%
Elongation, in 8 ins.	22.8%	29.0%	25.7%	24.7%	37.2%	32.8%	+27.6%	.....	.....	.....	.....	.....
Elongation, in 10 ft.	.....	.....	.....	.....	.....	.....	.....	9.0%	34.7%	22.5%	[−12.5%]*	[−31.4%]*
Reduction of area	36.2%	49.5%	42.4%	39.0%	61.7%	54.2%	+27.9%	17.9%	53.8%	40.3%	[− 5.0%]†	[−25.6%]†

*This comparison is between 10-ft. and 8-in. lengths.
†This comparison is between sections of greatly different shape.
NOTE.—Two eyebars which had no excess in head broke in head. Five eyebars fell below 33,000 in elastic limit, and two below 30,000, the lowest being 29,300, as stated in table; retests of bars from the same two heats gave satisfactory results. All bars included in averages.

comparing the pin-hole stretch for the 10-in. and the 12-in. end in the two cases:

Bar	Width of head.	Diam. of pin.	Stretch of pin-hole.
8 x 1⅞ ins. (Broke in 12-in. head at body stress of 62,210 lbs. per sq. in.)	20¼ ins.	10 ins.	1.58 ins.
	20¼ ins.	12 ins.	5.44 ins.
8 x 1⅝ ins (Broke in 12-in. head at body stress of 67,180 lbs. per sq. in.)	20 ins.	12 ins.	4.74 ins.
	20 ins.	10 ins.	0.96 ins.

These bars were included with the others in averaging the results for the present article. The subjoined table gives the average and the extreme figures obtained in the tests, both for the specimen (plain bar) and full size (eyebar) tests. It will be seen at once that on the average the full-size eyebars exceed the specified figures materially, in both ultimate strength and elastic limit, while the average elongation is almost double that asked (22.5% in 10 ft., as against 12% required).

We have also computed and give in the table a comparison of the eyebar and the original bar tests, in the shape of percentages of change from bar to eyebar. These are interesting in showing that while the eyebar is weaker than the unannealed original bar by 5 to 10%, *the full-size eyebar is practically equal in strength to the annealed plain bar.* It will be noted, of course, that the comparison of elongations is not significant, because the measurements are not on the same initial length, and that the comparison of reduction of area is of little more meaning, because the shapes of section are greatly different.

The average composition of the material is as follows:

	Min.	Max.	Av.
Carbon, %	0.24	0.30	0.26
Phosphorus, %	.010	.020	.018
Manganese, %	.50	.65	.59
Sulphur, %	.022	.040	.029

The detail table of test results, from which our figures were computed, shows no difference in the strength of large and small eyebars. Group averages are: Twelve 16-in. bars, 2 ins. and 2⅛ ins. thick, elastic limit, 34,900; ultimate, 63,100. Eight 10 and 12-in. bars, 1⅛ ins. to 1¾ ins. thick, elastic limit, 34,000; ultimate, 62,900. Four 8-in. bars, 1⅝ ins. thick, elastic limit, 35,100; ultimate, 63,900. These three sets of results are substantially identical. The carbon percentage did not vary with the size of bar.

These eyebars were forged from the plain bar at the American Bridge Co.'s Ambridge (Pa.) plant. After forging, they were slowly heated to a temperature of 1500° to 1600° F., then partially cooled in a muffle and finally cooled from red heat in the open air. The bar material was produced at Homestead, being rolled from 10-ton ingots; these were trimmed on the average of 50% (most of this at the upper end) and rolled to finished size in two heats. Of the largest bars, only one was produced from a single ingot, while of the smaller bars each ingot furnished two.

In the construction of this bridge Mr. J. A. Atwood, chief engineer, and Mr. A. R. Raymer, assistant chief engineer, Pittsburgh & Lake Erie R. R., were in direct charge. The bridge was built and erected by the McClintic-Marshall Construction Co., Pittsburg, Pa. We are indebted to Mr. Paul L. Wolfel, chief engineer of this company, for the copy of the complete tabulated test results, from which we have deduced the summarized figures given above. The detail results are given also in Mr. Raymer's comprehensive paper on the bridge, printed in "Proceedings of the American Society of Civil Engineers," Jan. 1911.

Fig. 4. South Abutment After the Slide (Looking Northwest).

Fig. 5. Face of Break in South Approach Fill (Looking Southwest).

FIGS. 4 AND 5. THE LANDSLIDE AND SOUTH ABUTMENT.

Myron C. Clark.

Myron Chace Clark, President of the Myron C. Clark Publishing Co., of Chicago, who died at Colorado Springs, Colo., on Feb. 11, was one of the hardest working, best-known and best-loved of all the American publishers of technical books and journals. His boyhood home was in the village of Bennington, Vt., and he received his education in the public schools there.

He came to New York City when still in his teens and took a minor position in the circulation department of the New York "World." Here he worked with such energy and showed such ability that he won rapid promotion and in a few months was given responsibilities such as usually fall to men of twice his age. Overwork, however, soon broke down his health and compelled him to undertake less arduous duties in business with a relative at Lakewood, N. J.

In 1897 he joined the staff of Engineering News. After serving in the Construction News Department, he took charge of, first, the Circulation Department and then of the Book Department in addition. In the dual capacity just named, his indefatigable, painstaking work, his readiness to aid in any task, his fidelity and ability to succeed in whatever he undertook, with his happy disposition and unlimited optimism won for him the confidence and friendship of all he served, including those who were associated with him daily and the thousands who knew him only by correspondence.

In 1904 Myron Clark launched out on an independent career as a publisher. His first great success was with Gillette's "Rock Excavation, Methods and Costs" which he published in 1904, and the "Handbook of Cost Data for Contractors and Engineers" published in the following year. These were followed by other engineering books.

In 1906 the same energy and optimism which in two years had made a young man with no capital of his own almost an object of envy among gray-haired publishers of technical books, led Myron Clark to found, with the assistance of Mr. H. P. Gillette, a new journal called "Engineering-Contracting," based on one or two papers of small size and circulation which had been purchased with that ultimate object in view. Clark became and to his death remained the President of the Myron C. Clark Publishing Co., which, besides issuing numerous books and the journal named, now publishes the "Roadmaster and Foreman" and "Contract News."

If close personal attention to every detail of one's work or business is a fault—and it may be—then that was the one great fault of Clark's character. Those who cannot overcome this failing, as responsibilities increase, pay the penalty sooner or later. Even when associated with Engineering News, Mr. Clark's health was temporarily impaired by close and long-continued application to work, much of which, by a less conscientious person, would have been left to others. After assuming larger and more direct personal responsibilities, unremitting work sapped Clark's nervous energy to such an extent that he was compelled to relax his efforts. Gradually it appeared that besides nerve strain he was suffering from tuberculosis. After a year or so spent at Colorado Springs he succumbed to the latter disease, leaving a widow, a mother and a sister, besides thousands of friends to mourn his loss.

A ROUNDHOUSE FIRE, Feb. 1, destroyed the seven-stall building of the Union Stock Yards Co. at 32nd and C Sts., Omaha, Neb. Two switch engines were saved, but two others were completely ruined, together with the equipment of the roundhouse machine shop.

A STREET-CAR FELL THROUGH an open drawbridge Feb. 9 at Sheboygan, Wis. Reports state that three persons inside the car were drowned. Those on the car platforms escaped by clinging to cakes of ice until rescued.

A LOCOMOTIVE BOILER EXPLODED Feb. 8 at Smithville, Tex., in the yards of the Missouri, Kansas & Texas Ry. Ten railway employees were killed and seven others injured. The locomotive that exploded had just been run out of the repair shop. Two other locomotives and the roundhouse were damaged.

THE MISSOURI STATE CAPITOL BUILDING at Jefferson City, Mo., was destroyed by fire Feb. 5. Reports state that the fire was started in the cupola on the dome by a stroke of lightning.

A COLLISION IN FRANCE Feb. 14 on the Western Ry. wrecked two express trains and one freight. Some ten persons were killed and several others injured. Reports state that the Paris and the Brest expresses collided simultaneously with a freight train which was being sidetracked.

MORE OPPOSITION TO LICENSES FOR ENGINEERS.—The Committee on Public Relations of the American Society of Mechanical Engineers at its meeting on Jan. 30 adopted resolutions respecting license laws covering engineering practice as follows:

WHEREAS, a bill is before the legislature of one of the states pertaining to the licensing of engineers to practice engineering,

RESOLVED, that it is the opinion of this Committee that it is unadvisable and impracticable to license engineers. Inasmuch as structures, boilers, plumbing, electric wiring, etc., are now regularly inspected, it is the sense of this Committee that instead of licensing engineers it would seem more practicable to extend inspection of the work of engineers as the wisest and most practical safeguard of the public interests.

This resolution was approved by the Council of the Society at its meeting on Feb. 14.

QUEBEC BRIDGE.—It is rumored in Ottawa that the report of the advisory experts, H. W. Hodge and M. J. Butler, on the plans and bids which the Board of Engineers has had under consideration for some time, will result in an award of the contract very shortly. The Board, having narrowed the choice to two bidders, divided on the question of which bid to recommend for acceptance, one member preferring the bid of the English syndicate on the Board's design, while the other two members preferred the bid of the Canadian syndicate on an alternate design. The two advisory experts being thereupon appointed to settle the difference, they have, it is rumored, decided in favor of the Canadian syndicate's bid.

AN OUTBREAK OF TYPHOID FEVER AT OTTAWA, Ont., is attributed to the temporary use of a water-works intake near the shore, where the water was liable to infection. The supply is ordinarily taken from a point well out in the river. On numerous occasions during December and early January the intake near the shore was opened, apparently to lessen the work put upon the water-power pumps at times when the reservoir above the Chaudiere Dam was low,, thus reducing the available head for water power. Investigations made by Dr. J. W. Cullough, Chief Health Officer of Ontario, and Mr. J. O. Meadows, Sanitary Engineer of the Provincial Health Department of Quebec, showed the pollution was from a recently annexed unsewered portion of the city known as Hintonburg, lying along Cave Creek. This creek is partly open and partly covered. Besides direct pollution, it is suggested by Mr. Meadows that thaws or rains in December and January washed fecal matter into the creek, the mouth of which is some 4,000 ft. from the shore intake. Hull, Que., which lies across the river from Ottawa and takes its water-supply from a point near the regular intake of the Ottawa works, Mr. Meadows states, has been practically free from typhoid of late. A hypochlorite plant has been installed at Ottawa.

PANAMA CANAL EXCAVATION during January totaled 2,772,170 cu. yds., a daily average of 110,887 cu. yds. for each of the 25 working days. The amount of concrete laid during the month was 137,960 cu. yds. and 544,610 cu. yds. of fill were placed in dams. The rainfall for January was 0.34-in. against 14.43 ins. in December.

Personals.

Prof. Henry S. Jacoby, Assoc. Am. Soc. C. E., has returned to Cornell University after a seven months' leave.

Mr. C. R. Thompson, formerly Professor of Mining at the University of Leeds, England, has been appointed professor of Mining at the South African School of Mines.

Mr. E. F. Lake, formerly Associate Editor of the "American Machinist" has opened an office in Bayonne, N. J., as a special correspondent and consulting metallurgist.

Mr. A. Q. Campbell, formerly Assistant Engineer of the Oregon Short Line Ry. at Ogden, Utah, has been appointed Assistant Superintendent of the Idaho Division, with headquarters at Pocatello, Idaho.

Mr. Ira A. McCormack has been appointed Assistant General Superintendent, Eastern District, of the New York Central & Hudson River R. R., with headquarters at the Barclay St. Station, New York City.

Mr. Charles H. Markham, recently elected President of the Illinois Central R. R., has also been elected President of the Central of Georgia R. R. and the Ocean Steamship Co., of Savannah, succeeding the late J. F. Hanson.

Mr. Charles H. Paul, M. Am. Soc. C. E., formerly Project Engineer, United States Reclamation Service, on the Minidoka Project at Rupert, Idaho, has been made Construction Engineer of the Arrow Rock dam to be built on the Boise River near Boise, Idaho.

Mr. Dwight Horton, Assoc. M. Am. Soc. C. E., has left the J. W. Maxcy Co., of Houston, Tex., to enter a partnership with Mr. F. D. Horton under the firm name of F. D. Horton & Son, to engage in a general contracting business with headquarters at Houston, Tex.

Mr. Edward J. Govern, M. Am. Soc. C. E., a consulting Engineer of Rochester, N. Y., has been appointed by State Engineer John A. Bensel, Division Engineer for the Western Division of the New York State Barge Canal, succeeding Mr. Thomas W. Barrally, M. Am. Soc. C. E.

Mr. Edwin A. Stevens, Assoc. Am. Soc. M. E., of the firm of Cox & Stevens, Consulting Engineers of Hoboken, N. J., has been appointed State Road Commissioner of New Jersey. Mr. Stevens is a mechanical engineer and a trustee of Stevens Institute of Technology.

Mr. Alfred E. Kornfeld, Business Manager of Engineering News, will leave New York on Feb. 23 for the east coast of Florida and the West Indies. He will visit Havana, Cuba, and see the progress made in raising the "Maine." He expects to return to New York about March 15.

Mr. C. A. Jennings, Chief Chemist and Superintendent of Filtration for the Union Stock Yards & Transit Co., of Chicago, Ill., has been engaged by Alvord & Burdick, Sanitary Engineers, of Chicago, as Resident Engineer to take charge of the installation of the hypochlorite of lime water-purification plant at Des Moines, Iowa. He is in charge of a similar permanent installation at Erie, Pa. These installations are being made because of prevailing typhoid fever epidemics.

Obituary.

Aaron F. Chapman, a contractor, of Buffalo, N. Y., died in a hospital at Washington, D. C., on Feb. 9, from pneumonia. He was 67 years old.

John H. Spitler, a prominent contractor of Toledo, Ohio, died in Toledo on Feb. 5, at the age of 75 years. He had been a resident of Toledo for 38 years.

George H. Watkins, member of the Ohio State Board of Public Works, died at his home in Portsmouth, Ohio, on Feb. 8, from a paralytic stroke. He was 54 years old and a native of Ohio.

Edmund Orville Mathews, Rear-Admiral U. S. N., retired, died at his home in Cambridge, Mass., on Jan. 30. He was born in Baltimore, Md., on Oct. 24, 1836. He graduated from the U. S. Naval Academy in 1855. He served in some of the earlier engagements of the Civil War but the larger part of this period was spent as an instructor at the Naval Academy. He was Chief of the Bureau of Yards and Docks from 1894 to 1898.

J. A. Wilkins, County Engineer and Engineer-in-Charge of drainage work for Lincoln County, Oklahoma, died at his home in Chandler, Okla., on Jan. 31. At the close of the Civil War he was engaged as a locating engineer on railways in southern Iowa. He was in charge of location and construction on the Minneapolis, St. Paul & Sault Ste Marie Ry. in northern Michigan, the Duluth & Iron Range R. R. in Minnesota, and for a number of years was with the Chicago Great Western Ry.

John Thomas Fanning, M. Am. Soc. C. E., for many years one of the most noted hydraulic engineers of this country, died at his home in Minneapolis, Minn., on Feb. 6, from an attack of pneumonia, after an illness of about ten days. He came of an old New England family which settled in America in 1652. He was born at Norwich, Conn., on Dec. 31, 1837. Here his early education was received in the public schools and at the Normal School. He then studied engineering and architecture and had begun to practice in his native town at the outbreak of the Civil War. He at once enlisted in the 3d Connecticut Volunteer Infantry and served throughout the war, retiring with an honorable record and the rank of Lieutenant-Colonel.

After the close of his military career Mr. Fanning again opened an office in Norwich for the general practice of engineering. He soon began to specialize in hydraulics and his reputation soon made him in demand throughout New England in the solution of hydraulic and water supply problems. He was engaged as an expert for the water supplies of many large Eastern cities, including New York and Brooklyn.

He first went to Minneapolis in 1885, to report on the power development of the St. Anthony Falls, and was so favorably impressed with the Western country that he made his home in that city. Since settling in Minneapolis Mr. Fanning had acted as consulting engineer on many large water-power projects, including those on the Big Hole River, and at Great Falls and Helena, Mont., and at Spokane, Wash. He has also acted as consulting engineer for the Great Northern Ry. and the Minneapolis Union Rys., besides having been called in consultation by many others.

In later years he has also been connected with the planning and construction of numerous water supply and purification systems in Des Moines, Omaha, Birmingham and other cities. He was intimately connected with the water supply development of his home city, not only in an official advisory capacity at various times, but it is also said that he was very generous in helping, in an unofficial way, younger and less experienced engineers, from his vast fund of knowledge and experience.

He was the author of the well-known text-book "A Treatise on Hydraulic and Water Supply Engineering," and contributed a number of papers to the Transactions of the American Society of Civil Engineers, of which society he had been a member for 38 years, and at the time of his death a Vice-President. He was an active member of the Engineers Club of Minneapolis, Past-President of the American Water-Works Association, a fellow of the American Association for the Advancement of Science, an honorary member of the New England Water-Works Association, a member of the Franklin Institute of Philadelphia and other scientific and technical societies.

He was married in 1865 to Miss Maria Louise Bensley. Their three children survive. The son, R. B. Fanning, is an engineer of Minneapolis and for several years had been associated with his father. He is at present the President of the Engineers Club of Minneapolis.

Engineering Societies.

COMING MEETINGS.

ILLINOIS WATER SUPPLY ASSOCIATION.
Feb. 21-22. Annual meeting at the University of Illinois. Secy., E. Bartow, Urbana, Ill.

APPALACHIAN ENGINEERING ASSOCIATION.
Feb. 24-25. Annual meeting at Pottsville, Pa. Secy., Henry M. Payne, Morgantown, W. Va.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.
Feb. 28-March 1. Annual convention at Minneapolis, Minn. Secy., Harvey B. Smith, 834 Security Bank Bldg., Minneapolis, Minn.

ENGINEERING SOCIETY OF WISCONSIN.
March 1-3. Annual meeting at Madison, Wis., Secy., W. G. Kirchoffer, Vroman Bldg., Madison, Wis.

CANADIAN MINING INSTITUTE.
March 1-3. Annual meeting at Quebec, Que. Secy., H. Mortimer Lamb, Windsor Hotel, Montreal, Que.

CANADIAN CEMENT AND CONCRETE ASSOCIATION.
March 7-9. Annual convention at Toronto, Ont. Secy., Wm. Snaith, 57 Adelaide St., East, Toronto, Ont.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 21-23. Annual convention at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago, Ill.

ENGINEERS' CLUB OF ST. LOUIS.—At the regular meeting of Feb. 15, Mr. A. O. Cunningham, Chief Engineer of the Wabash R. R., presented a paper on "Strengthening the Columns of the Approaches of the St. Charles Bridge."

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—At the third annual convention, March 7-9, at Toronto, Ont., papers will be presented as follows: "Cement Concrete in Highway Construction," W. A. McLean, Provincial Engineer of Highways; "Cement Surfaces and Finishes," Robt. Cathcart, Glidden Varnish Co., Cleveland, Ohio; "Concrete Blocks," R. F. Havlick, Ideal Concrete Machinery Co., South Bend, Ind.; "The White and the Gray," Joseph M. Carrere, Blanc Stainless Cement Co., Allentown, Pa.; "Prevention of Corrosion in Metal Lath," C. W. Noble, consulting engineer, Toronto, Ont.; "Adaptation of Concrete for Long Span Bridges," F. Barber, Barber & Young, Bridge and Structural Engineers, Toronto, Ont.; "Manufacture of Portland Cement," W. M. Kinney, Assistant Inspecting Engineer, Universal Portland Cement Co., Pittsburg, Pa.; "The Necessity of Inspection in Concrete Work," E. A. James, Editor, "Canadian Engineer," Toronto, Ont. Mr. Richard L. Humphrey, Director of the United States Structural Materials Testing Laboratories, Pittsburg, Pa., and several others have consented to read papers, but their subjects have not yet been chosen.

The third annual Cement Show will be held at the St. Lawrence Arena, Toronto, Ont., March 6-11. Mr. William Snaith, Secretary of the Association, is also Manager of the Cement Show.